# Analysis of Accidents
# Related to Scaffolding and Floor/Wall Openings

by

John Vincent Heckmann, Jr.



A thesis submitted in partial fulfillment
of the requirements for the degree of

Master of Science

University of Washington

1995

Approved by Jimmie Hinze
Chairperson of Supervisory Committee



Program Authorized
to Offer Degree Master of Science

Date 7 DEC 1995

Master's Thesis

In presenting this thesis in partial fulfillment of the requirements for a Master's degree at the University of Washington, I agree that the Library shall make its copies freely available for inspection. I further agree that extensive copying of this thesis is allowable only for scholarly purposes, consistent with "fair use" as prescribed in the U.S. Copyright Law. Any other reproduction for any purposes or by any means shall not be allowed without my written permission.

Signature________________

Date 7 DEC 1995

University of Washington

Abstract

# Analysis of Accidents Related to Scaffolding and Floor/Wall Openings

by John Vincent Heckmann, Jr.

Chairperson of the Supervisory Committee: Professor Jimmie W. Hinze
Department of Civil Engineering

Scaffolding and floor/wall openings are common potential hazards at construction sites and account for a significant number of accidents, many resulting in fatalities. The major types of scaffolds used in construction is reviewed and accompanied by illustrations. The liability involving scaffold and floor/wall opening accidents is also examined as associated with past and present case law. Accidents recorded under the Occupational Safety and Health Administration's (OSHA) Integrated Management Information System (IMIS) from 1985 to 1994 related to scaffolding or floor/wall openings were reviewed. Statistics were compiled about numerous characteristics of the scaffold and floor/wall opening accidents including: timing of accident, location of accident, company size, type work being performed, scaffold type, size opening, apparent causes, OSHA standards violated, and various information on the injuries sustained. By far, most of the scaffold and floor/wall opening accidents investigated were fall-related. Scaffold accidents generally involved the tubular welded frame type associated with masonry construction. The most common causes of scaffold accidents were a lack of guardrails and unsecure planking. Floor/wall openings accidents were mostly involved with open-sided floors and associated with roofing operations. The most common causes of floor/wall opening accidents were the lack of guards, inadequate covering, and the failure to use personal lifelines.

# TABLE OF CONTENTS

## TABLE OF CONTENTS (cont)

## LIST OF FIGURES

## LIST OF FIGURES (cont.)

*Number* *Page*

## LIST OF FIGURES (cont.)

*Number* *Page*

## LIST OF TABLES

## ACKNOWLEDGMENTS

The author wishes to express sincere appreciation to Professor Jimmie Hinze for his assistance in the preparation of this manuscript and general guidance throughout the research of this topic. In addition, special thanks to Carm Sherlock of the Region X Occupational Safety and Health Administration Office for providing the data used in this research and explaining the structure of the Integrated Management Information System database.

## DEDICATION

To Lisa, my wife, and Hannah, my daughter who was born during the preparation of this manuscript.

## Introduction

On April 27, 1978, a construction scaffold collapsed during the construction of a cooling tower on the Ohio river and killed 51 workers.[1] On August 23, 1989, a four-story high scaffold collapsed in New Orleans, Louisiana. Amazingly, no one was injured in the shops and restaurants below as rubble fell into the street .[2] On September 28, 1993, a seven-story scaffold section collapsed killing one worker and injuring five others in Bridgewater, New Jersey.[3]

These are three examples of how temporary structures, required for construction projects, subject workers and others to considerable danger. Contractors are continually being required to conduct construction in restricted work area locations close to or open to public areas. This creates a safety and liability problem for contractors, their employees, and the public. Fortunately, accidents involving the public are not very common. Unfortunately, accidents involving the contractor's own employees and those of the subcontractor's employees are all too common. Projects to be constructed are carefully reviewed and checked for general safety during the design process by engineers. However, the method of construction is usually left up to the contractor. This method of construction dictates the type and style of temporary structures required. Many contractors do not properly design these temporary structures, but rather rely on "experience" from other projects and commonly reuse materials for these structures. This "second billing" of temporary structures often puts it into a gray area with project management and never gets the proper attention it deserves. This lack of attention often leads to injuries, Occupational Safety and Health Act (OSHA) violations, and potential liability for those involved with the construction project.

---

[1]Helander, M. ed., *Human Factors/Ergonomics for Building and Construction*, New York: Wiley, 1981, p13
[2]"ENR News" *Engineering News Record*, Aug 31, 1989, p14
[3]"ENR News" *Engineering News Record*, Oct 11, 1993, p12

Scaffolding, as used in the construction industry, is defined as a temporary work platform used to place the worker in the proper position to accomplish the assigned task. Of the many temporary structures used in construction, scaffolding is the most common. Scaffolds can vary from pre-engineered assemblies of metal tubes to wood pole scaffolds and can be either stationary or movable. With specific purposes and limitations on each type of scaffold, the potential for misuse is great when contractors undertake differing projects. The seriousness of the hazards posed by scaffolding cannot be understated. From 1980 to 1985 falls involving scaffolding accounted for 17% of all fall related deaths second only to falls from buildings.[4]

A very closely related temporary structure includes the guarding of floor and wall openings during construction. The principle danger with either scaffolds or floor/wall openings is falling. Thus the procedures and materials used to avoid floor and wall opening hazards, such as guardrail and lifeline requirements, are similar to scaffolding. Because of this similarity, accidents occurring from floor and wall openings were included in this study.

---

[4]"Scaffold Falls Could Be Prevented" *BNA Construction Labor Report*, Feb 10, 1993, v38 p1417

## Chapter 1

## Scaffolding Types, Regulations, and Liability

The following consists of a description of scaffolding involved with construction and the obvious safety concerns for each type. Later, the efforts of OSHA with regard to scaffolding safety will be examined. Finally, a review will address the liabilities involved with scaffolding accidents.

### Types of Scaffolding

Nearly every construction project that does not consist of exclusively horizontal work will probably require the use of some means of raising or elevating the worker to the level required to perform the work. Unfortunately, no one type of scaffold will satisfy all construction needs, i.e., no two construction sites are alike. The same can be said of the scaffolding used at various construction sites. A number of factors are considered when determining the type of scaffold to use, including:[5]

- Feasibility of Erection - Will the disposition, size, shape, and strength of the scaffold allow it to be erected with or without the use of machinery at the required location?

- Economics - Do the initial purchase costs, maintenance costs, ability to reuse, and ease of erection/dismantling make it cost effective?

- Structural Stability - Can the scaffold support itself and the applied load with an adequate safety factor?

- Safety - Will the structure be safe under the intended use?

---

[5]Rossnagel, W.E., et al., *Handbook of Rigging for Construction and Industrial Operations*, New York: McGraw-Hill, 1988, p379

If safety is not given adequate consideration, inappropriate scaffolding may be selected for use in a construction application. Failure to consider all of the above factors in selecting the type of scaffolding may be the major contributor to scaffolding accidents. The influence of economics may push a contractor to use existing scaffolding even though another type would be more suitable. Another major reason for scaffold accidents may be improper erection of an appropriately chosen scaffold. To better understand the safety aspects of scaffolding it is important to understand the various types of scaffolding available and the unique safety concerns of each. Scaffolds generally fall into four primary categories:[6]

- Swinging or Suspended Scaffold - Usually consists of a two-point suspension system supported from outriggers anchored from overhead. Vertical adjustment can be made by manual or mechanically-operated hoisting devices.

- Stationary Scaffold - Self-supporting structures that can stand independently or acquire lateral support from an existing structure.

- Special Scaffolds - Unique suspended or stationary systems required for special construction applications.

- Movable Scaffolds - Systems supported on the ground and capable of relatively easy movement by hand or motor.

**Swinging or Suspended Scaffolds**

Swinging or suspended scaffolds are made in a variety of sizes to match the requirements for construction. Scaffolds of this type generally are used for applications where access to a large wall surface is required with short duration up and down movements. Painting,

[6]ibib. p 379-380

cleaning, and repairs of existing buildings is the most common use. Such scaffolds are commonly hung (suspended) by rope from outriggers anchored at the top of the building. Suspension can consist of one or multiple points depending on the load to be supported. OSHA defines standards for the following suspension scaffold types:[7]

- Two-Point Suspension Scaffold (Swinging Scaffold)
- Single-Point Adjustable Suspension Scaffold
- Boatswain's (Bosun's) Chair
- Masons' Adjustable Multiple-Point Suspension Scaffold
- Stone Setters' Adjustable Multiple-Point Suspension Scaffold

Two-point suspension scaffolds are the most widely used of suspended scaffolds as they provide the largest range of uses compared to other suspension types. As the name implies, this type operates from two points of suspension as shown in Figure 1. Both the single-point (Figure 2) and boatswain's chair (Figure 3) are supported by a single rope system. Transfer of materials or single workers is generally done with this method. Two-point and single-point systems are generally supported from the roof by one of two types of supports and tie-back systems, as shown in Figure 4. Masons' and stone setters' systems are similar and generally are designed for heavy construction or repair work as opposed to the two-point suspension which handles lighter operations. The multiple suspension system allows for a greater load capacity than two points and therefore is better suited to handle brick and stone work. A cross section of a mason's adjustable multi-point suspension scaffold is shown in Figure 5.

The obvious safety concerns associated with the suspended scaffold involve the support of the working platform and the working platform itself. Whether it is a single, two-point or

---

[7] 29 CFR Part 1926.451, revised July 1, 1994

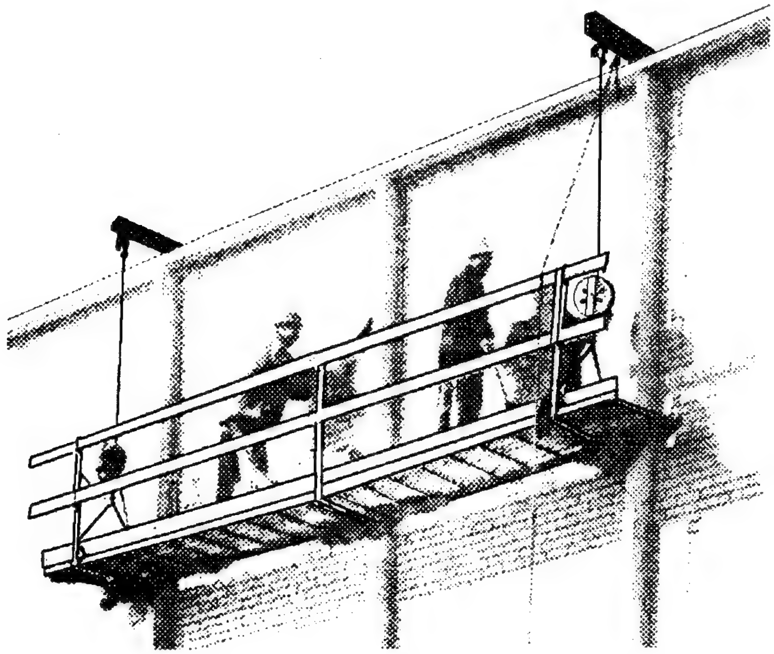

Figure 1: Two-Point Suspended Scaffold (29 CFR 1926.451(i))

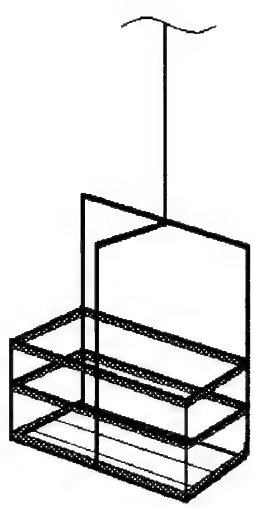

Figure 2: Single-Point Suspended Scaffold (29 CFR 1926.451(k))

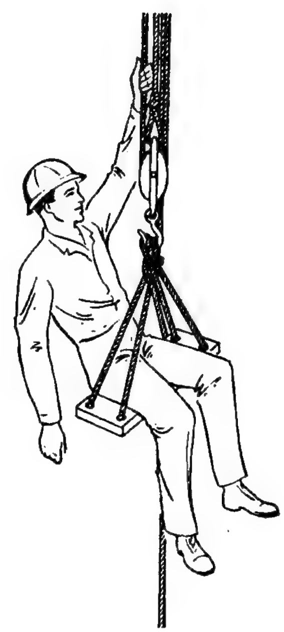

Figure 3: Boatswain's Chair (29 CFR 1926.451(l))

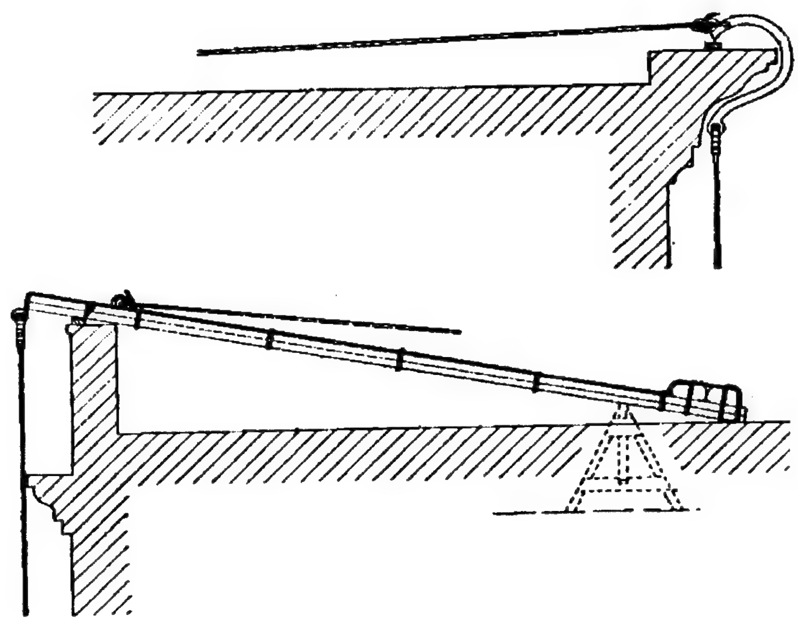

Figure 5: Two-Point or Single-Point Suspension Tie-Back Systems

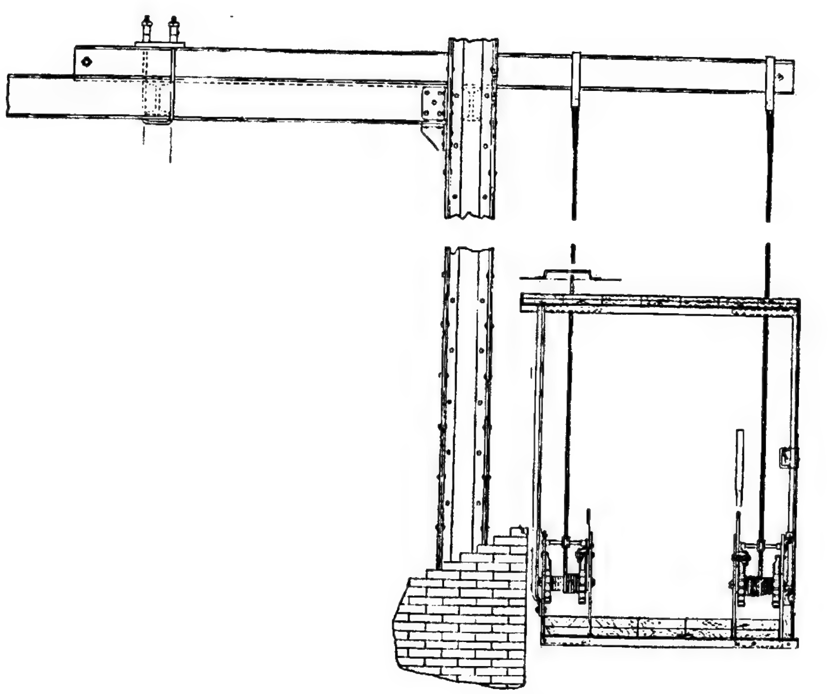

Figure 4: Mason's Multi-Point Suspension Scaffold Cross Section
(29 CFR 1926.451(h))

multiple system, the importance of the suspension material (wire, synthetic or fiber ropes) cannot be under emphasized. The next critical aspect is the platform supporting the workers and materials. OSHA requires a safety factor of 6 for the rope loading while the scaffold platform itself requires a safety factor of 4. In a traditional scaffold there may exist multiple layers of working platforms which could limit the fall of workers or material. This is not the case with suspension scaffolds. To compensate, at least in the case for OSHA's two-point suspension, workers are required to be equipped with safety belts tied off to a lifeline.

Testing of the scaffold is not addressed in the OSHA standards but it is recommended by Rossnagel et al.[8] Prior to use, and thereafter every 10 days, a minimum of 4 times the anticipated load should be applied, raised to a height of 12 inches and held for 5 minutes. The small amount of time invested for this test will likely identify simple flaws that could be life threatening at typical working heights.

**Stationary Scaffolds**

Stationary scaffolds are the most common types of scaffolding used at construction sites and can be categorized in three groups: independent self-supporting, partially self-supporting, and cantilevered. Constructed of either wood or metal, stationary scaffolds generally are supported from the ground up in either a built-up or prefabricated system. Built-up systems have the greatest flexibility as more sections can added to obtain additional height. OSHA defines standards for the following suspension scaffold types:

- Wood Pole Scaffold
- Tubular Welded Frame Scaffold
- Tube and Coupler Scaffold

---

[8]Rossnagel, W.E., et al., *Handbook of Rigging for Construction and Industrial Operations*, New York: McGraw-Hill, 1988, p394

Wood pole scaffolds offer a very flexible option for scaffolding needs. Generally any size or shape can be built. The primary disadvantages of wood are the requirement for reasonably defect-free lumber and the effort required to design and erect the scaffold. Splicing of long members also becomes a problem which can weaken the structure. Contractors usually overcome these problems by reusing scaffold lumber and limiting wood pole designs to relatively small applications. A cross section of a wood pole scaffold is shown in Figure 6.

Both the tubular welded frame, and tube and coupler scaffolds have the advantages of metal strength, ease of erection, and resistance to deterioration. Tubular welded frame scaffolds are the most popular because of the relative ease of erection. As shown in Figure 7, this system can be erected with minimal training and effort compared to other systems. Tube and coupler scaffolds are constructed, similarly to wood pole scaffolds, with varying lengths of tubular steel, each connected with couplers as shown in Figure 8. While requiring more training to design and erect, tube and coupler scaffolds offer the flexibility to install working platforms at locations the pre-engineered tubular welded frame scaffolds cannot.

The modular design of metal scaffolds make them a popular choice for flexible applications to most scaffolding needs. The largest safety concern for metal scaffolds is over-estimating its capability. Like most stationary scaffolding it is weakest in the lateral direction. If dynamic loads, such as wind or construction loads, are not anticipated failure may result. When assembled properly in accordance with the OSHA standards, metal scaffolds can provide a very reliable temporary structure. Another concern with both metal and wood stationary scaffolds is the suitability of the base. Since all the support starts at the bottom it is critical that the ground can support the intended load. To select the correct stationary scaffold, whether of wood or of the variety of metal strengths and

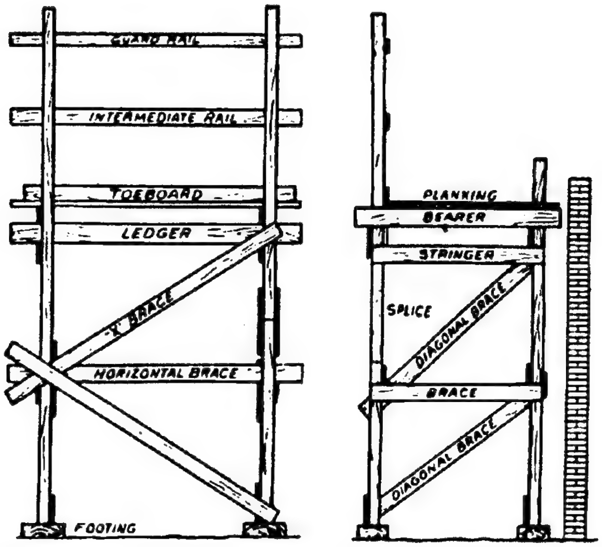


Figure 6: Wood Pole Scaffold Cross Section
(29 CFR 1926.451(b))

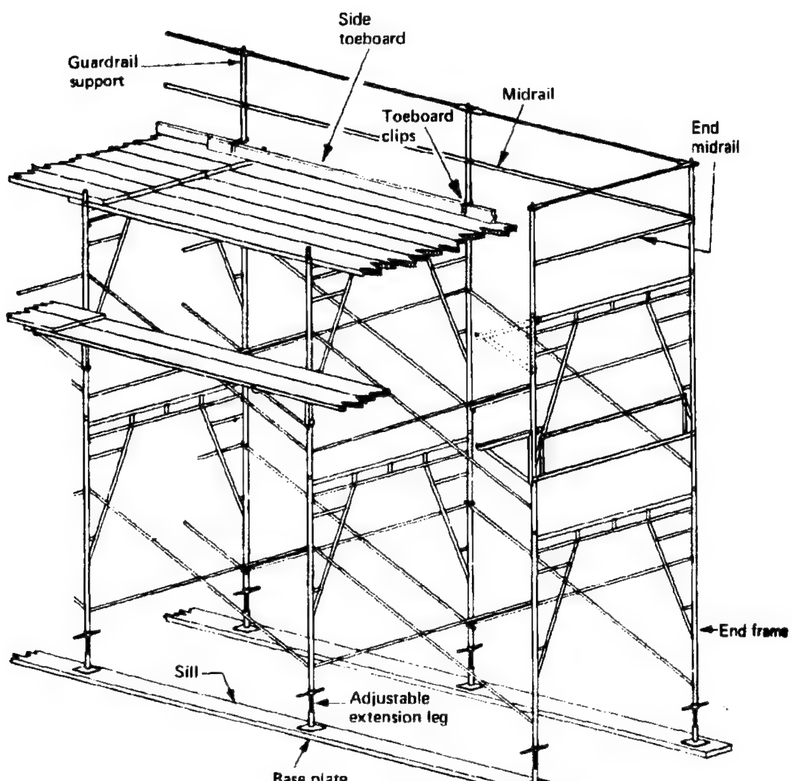


Figure 7: Tubular Welded Frame Scaffold (29 CFR 1926.451(d))

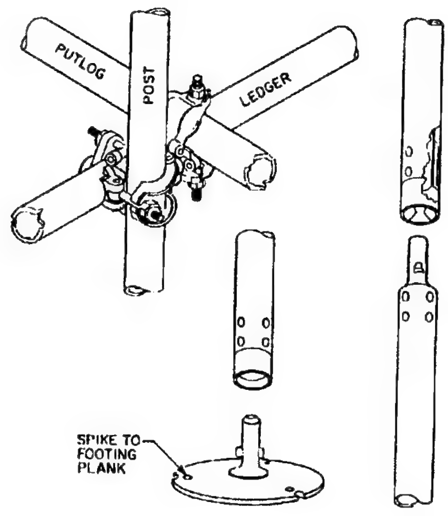


Figure 9: Tube and Coupler Scaffold Connections (29 CFR 1926.451(c))

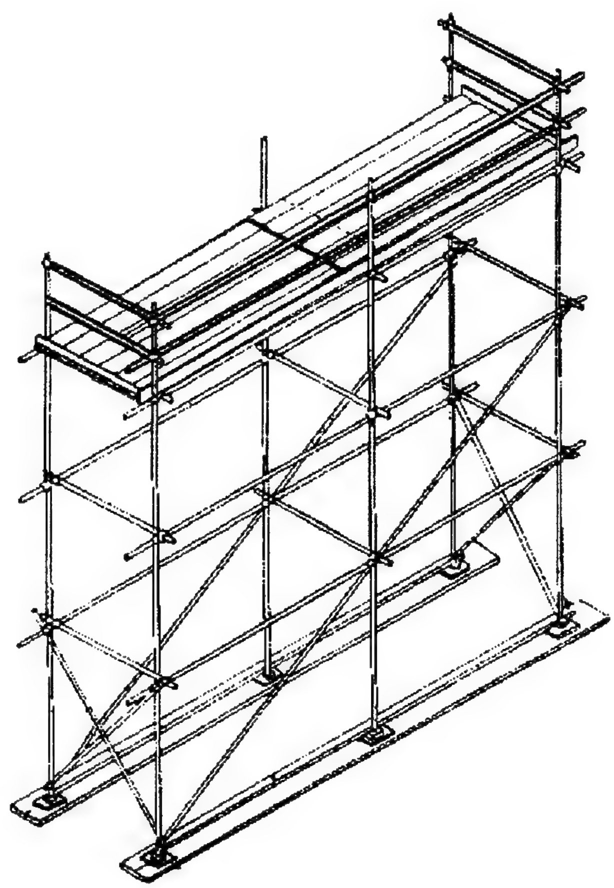

Figure 8: Tube and Coupler Scaffold (29 CFR 1926.451(c))

alloys available, the following factors need to be considered for each construction application:[9]

- Load-carrying capability.
- Availability.
- Corrosion resistance.
- Beam strength.
- Ease of handling.

**Special Scaffolds**

A variety of scaffolding types exist for unique construction requirements. These can include suspended or stationary support systems and can be either free standing or depend on the existing structure for support. They can be constructed of either wood, metal or a combination of both. Overall, their application is limited to the special circumstances of their design. OSHA defines standards for the following suspension scaffold types:

- Outrigger Scaffold
- Carpenters' Bracket Scaffold
- Window Jack Scaffold
- Roofing Bracket Scaffold
- Horse Scaffold
- Bricklayers' Square Scaffold
- Plasters', Decorators' and Large Area Scaffold
- Needle Beam Scaffold
- Interior Hung Scaffold
- Ladder Jack Scaffold
- Pump Jack Scaffold
- Float or Ship Scaffold
- Form Scaffold
- Crawling Boards or Chicken Ladders

Outrigger, window jack, carpenters' bracket, and roofing bracket scaffolds all operate on the cantilever principle requiring support from the existing structure. Outrigger scaffolds,

[9]ibib. pp405-406

as shown in Figure 10, and window scaffolds, as shown in Figure 11, require the use of an open window or similar opening in the wall. Their applications are limited due to their dependence on the wall openings for support. Carpenters' and roofing bracket scaffolds make use of a triangular support bracket anchored to the wall or roof framework as shown in Figures 12 and 13, respectively.

The horse scaffold is the simplest platform consisting of two saw horses with a platform placed on top as shown in Figure 14. It is generally used in residential construction for work to be performed up to heights of 10 feet. Bricklayers' square scaffolding is a simple assembly of framed wooden squares used as a strong base as shown in Figure 15. Both the horse and bricklayer's square scaffolds can be stacked with additional layers but are limited by CFR regulation to 2 and 3 layers respectively. The plasters' decorators' and large area scaffold, as shown in Figure 16, is an interior scaffold constructed similar to a stationary wood pole scaffold, except with greater depth, and used to work on interior walls and ceilings.

The needle beam, interior hung and float/ship scaffolds are suspension type scaffolds with no vertical mobility. Each type various by the method of suspension from ceiling or roof structures as shown in Figures 17, 18 and 19, respectively. The same safety concerns of the swinging scaffolds apply to these systems.

Ladder jack and pump jack scaffolds are commonly used to provide a raised platform for exterior residential construction. Ladder jacks simply rely on two ladders or one ladder with another structure for support as shown in Figure 20. With such a dependence on ladders for support the ladder strength and stability become very important safety concerns. Additionally, there are no provisions for guardrails so height is limited and lifelines are recommended. Pump jacks, however, have a built-in work bench which can serve as a guardrail. The pump jack operates by clamping onto a pole of double 2x4's

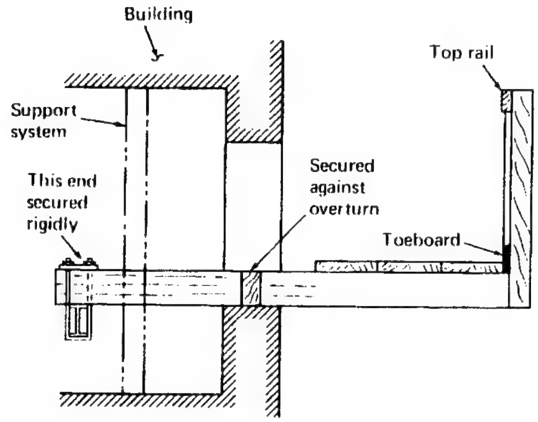


Figure 10: Outrigger Scaffold Cross Section

(29 CFR 1926.451(g))

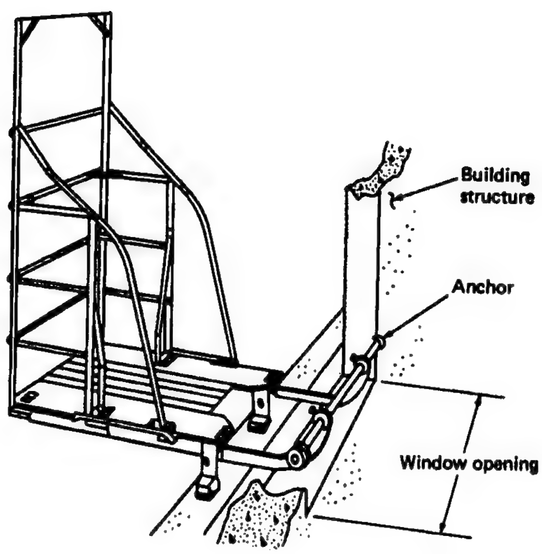


Figure 11: Window Jack Scaffold (29 CFR 1926.451(t))

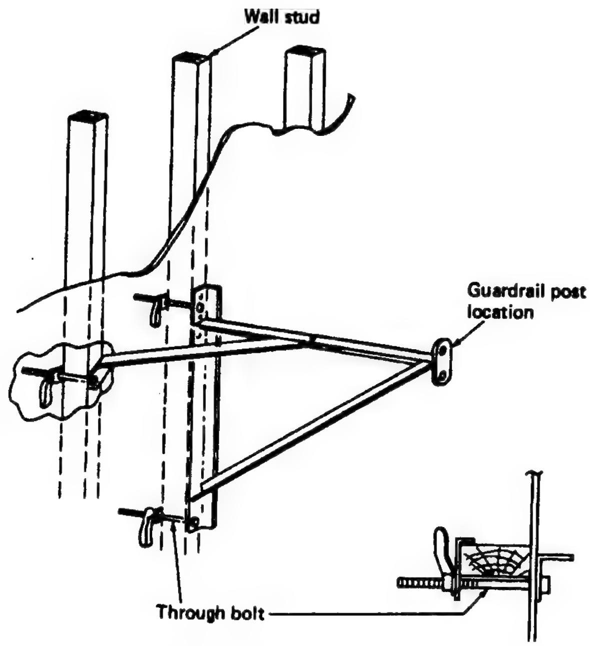


Figure 12: Carpenter's Bracket Scaffold
(29 CFR 1926.451(m))

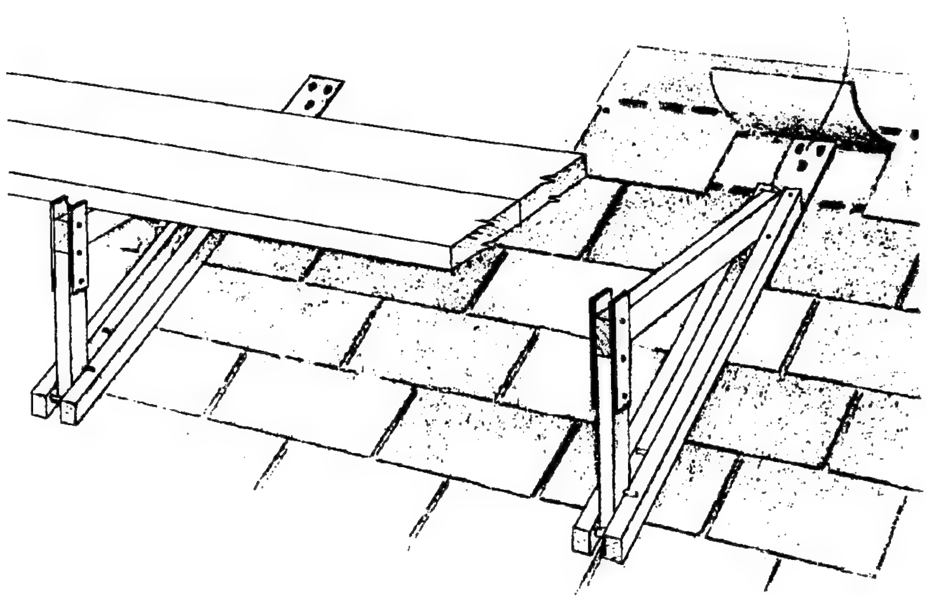

Figure 13: Roofing Brackets (29 CFR 1926.451(u))

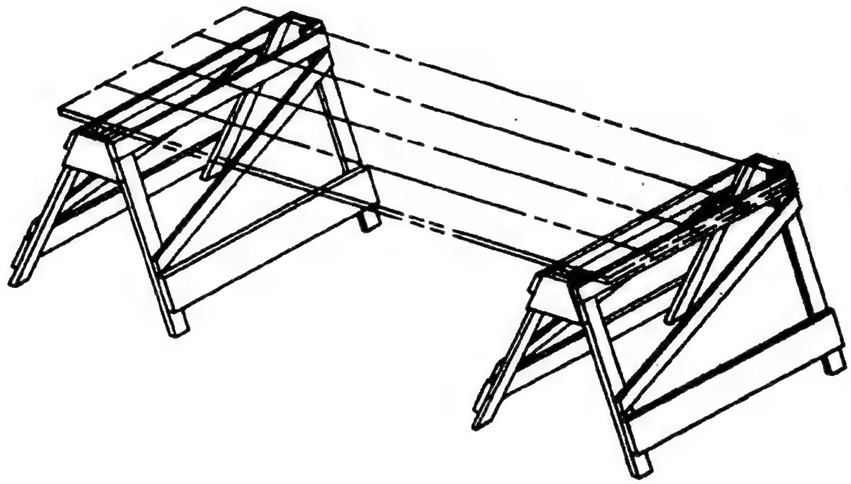

Figure 14: Horse Scaffold (29 CFR 1926.451(o))

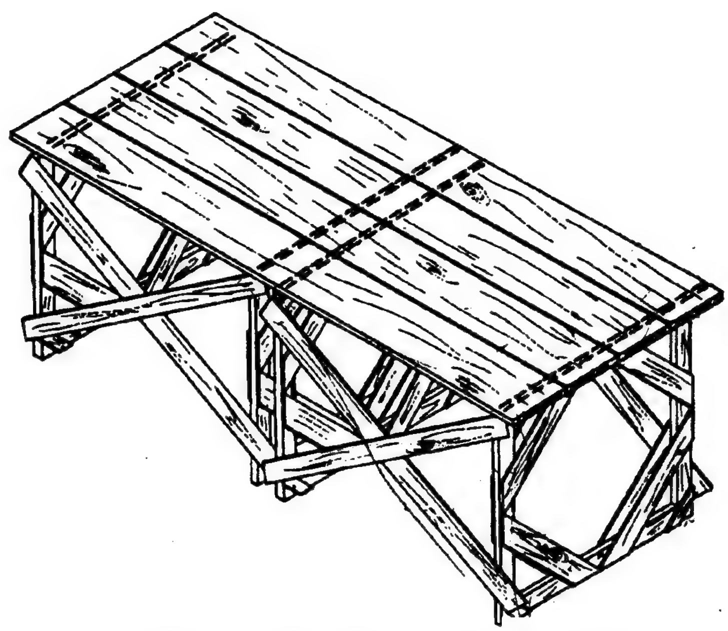

Figure 15: Bricklayer's Square Scaffold
(29 CFR 1926.451(n))

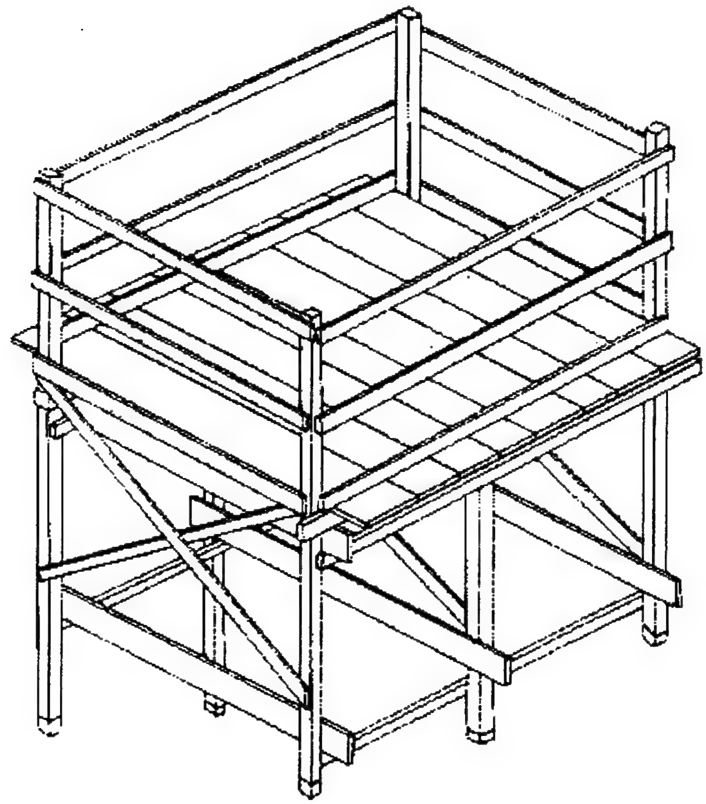

Figure 16: Plaster's, Decorator's and Large Area Scaffold (29 CFR 1926.451(q))

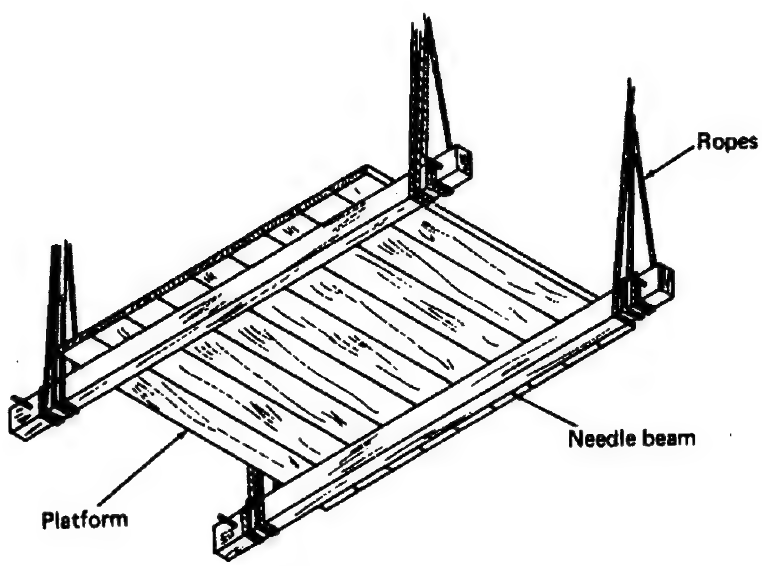


Figure 17: Needle Beam Scaffold (29 CFR 1926.451(p))

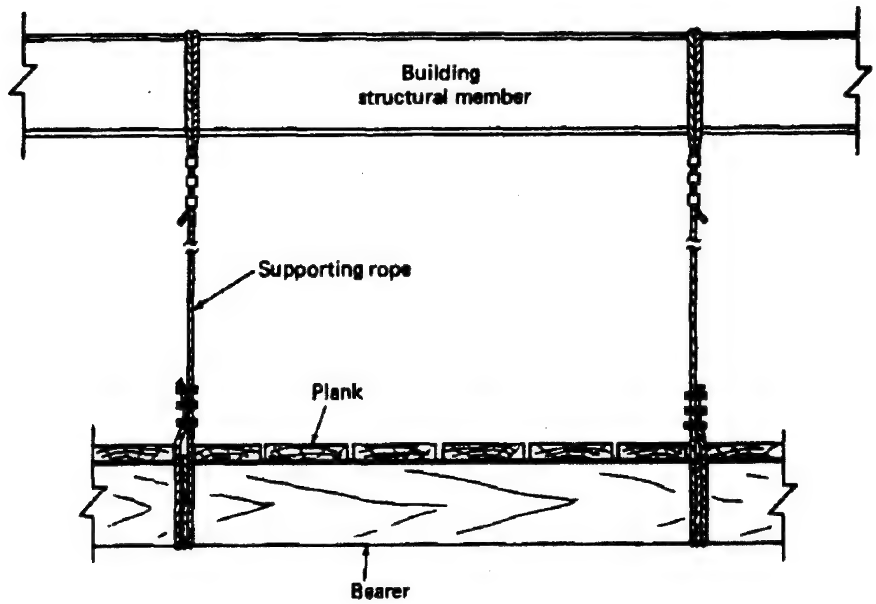


Figure 18: Interior Hung Scaffold Cross Section (29 CFR 1926.451(r))

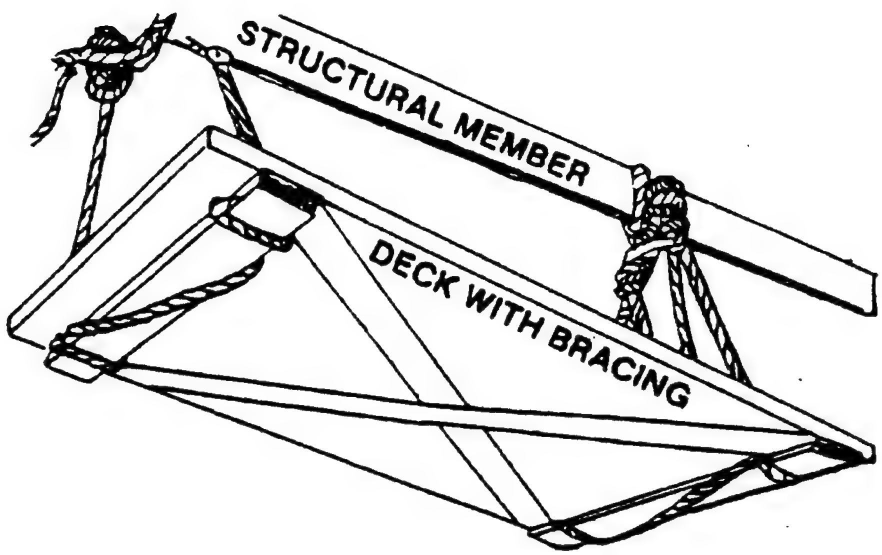


Figure 19: Float or Ship Scaffold (29 CFR 1926.451(w))

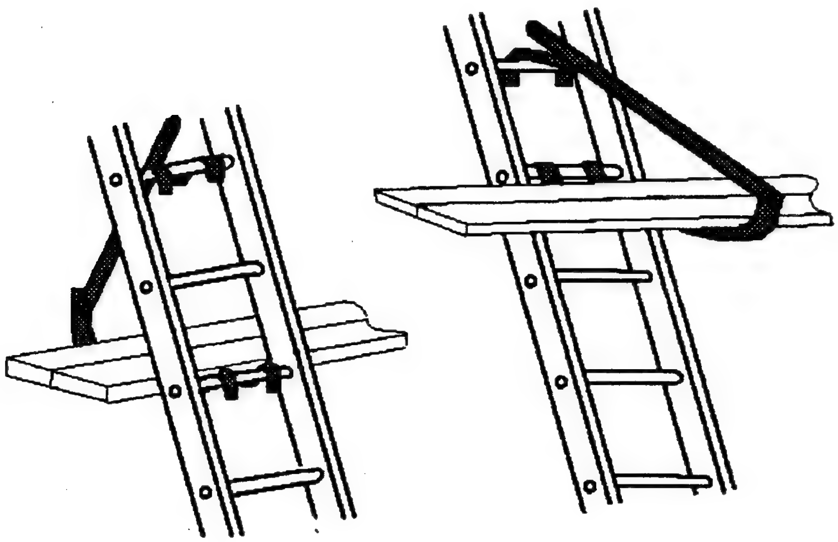

Figure 20: Ladder Jack Scaffold (29 CFR 1926.451(s))

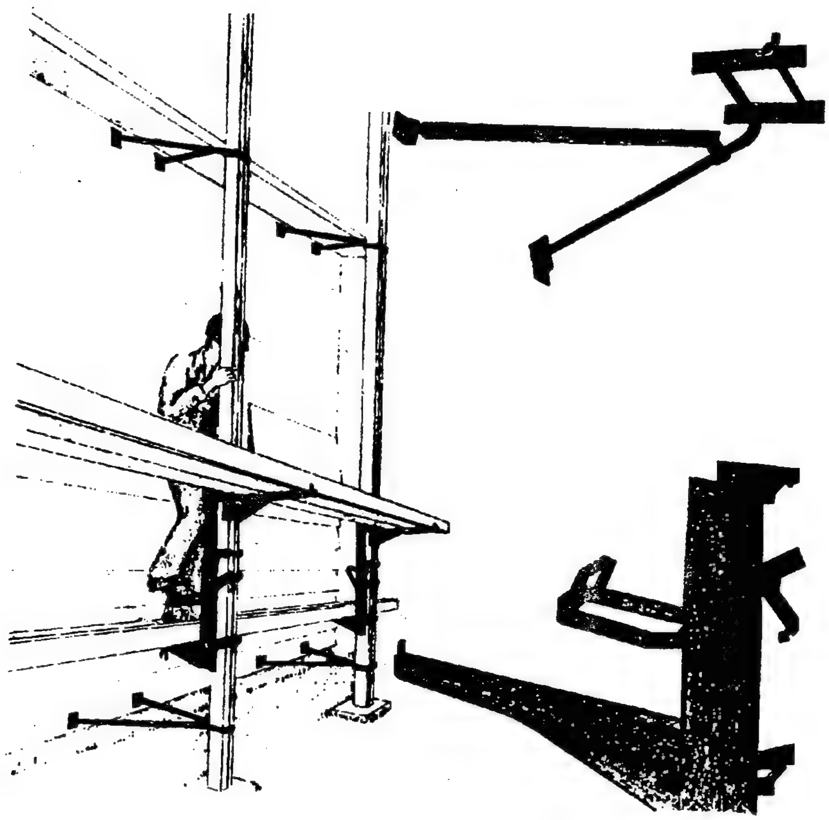

Figure 21: Pump Jack Scaffold (29 CFR 1926.451(y))

anchored to the existing structure as shown in Figure 21. It can be raised by the operator by a foot pump. Again, it is limited to light construction and has a height limit of 30 feet.

Crawling boards (or chicken ladders, as they are also known) and form scaffolds are very specialized for their intended purposes. Crawling boards or chicken ladders are used for roof construction where the top is hooked to the roof ridge for support as shown in Figure 22. This provides a non-slip platform and prevents damage to roof surfaces. Form scaffolds are used to provide access to the tops of concrete formwork as shown in Figure 23. Since the form scaffold depends on the concrete forms for support, extra measures should be taken to ensure the proper erection and bracing of the formwork.

A safety concern apparent with specialized scaffolds is not their inherent design but their ultimate use, i.e., scaffolds might be used in applications for which they were not intended. Trying to use these scaffolds for anything other than their intended purpose could seriously compromise worker safety. Additionally, many specialized scaffolds do not have guardrails installed and, therefore, depend on lifelines for proper fall protection.

**Movable Scaffolds**

The last category of scaffolds includes all forms of movable scaffolds which consist of either manually-propelled or motor-driven types. Because of the regular lateral forces being applied to these scaffolds during movement they are nearly exclusively made of metal or metal alloys. Manually-propelled scaffolds typically are constructed of tubular welded metal members supported by casters which allow movement in two directions and can be locked into position, as shown in Figure 24. Their height is limited to 4 times the least base dimension because of the lateral forces involved. The benefits of mobility can outweigh the height limitation in many situations. If a suitable level base is available and free of obstructions, a movable scaffold can eliminate the need to erect an extensive stationary scaffold system.

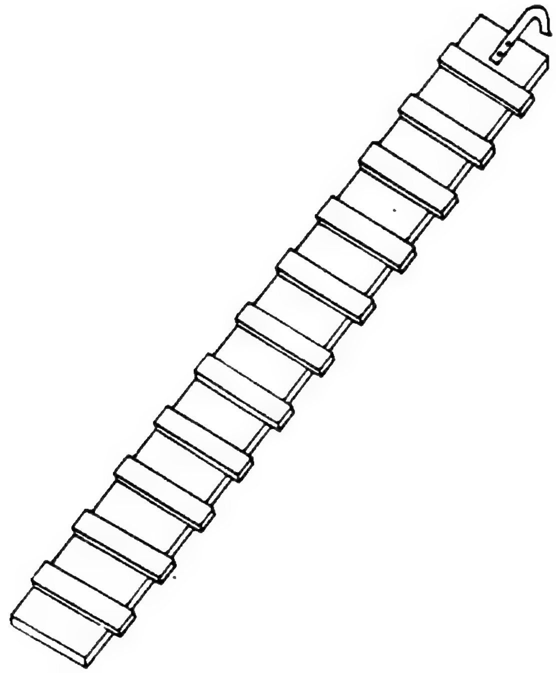

Figure 22: Crawling Board or Chicken Ladder
(29 CFR 1926.451(v))

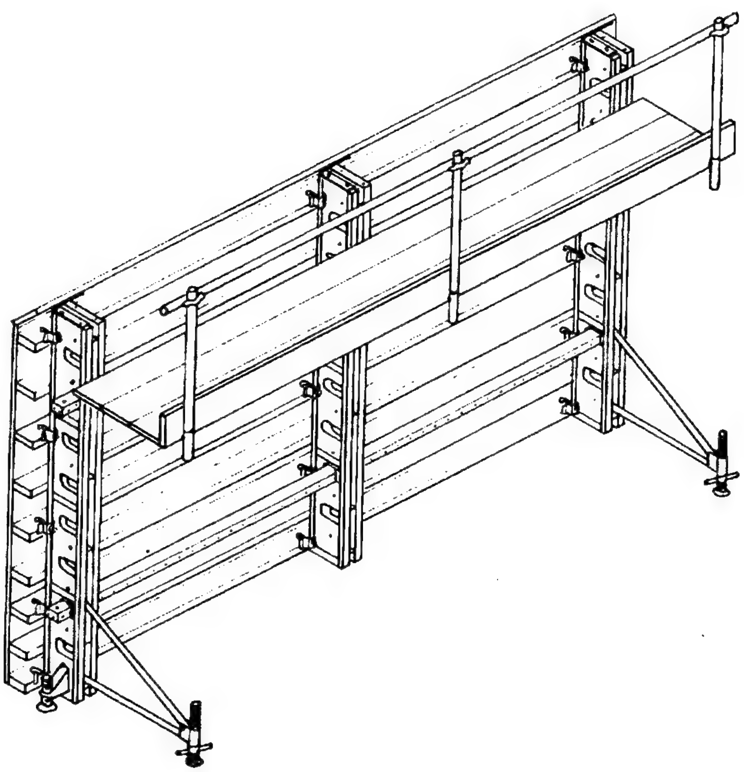

Figure 23: Form Scaffold (29 CFR 1926.451(x))

Motor-driven scaffolds can take on a variety of shapes such as scissor lift designs and truck-mounted boom designs, as shown in Figures 25 and 26. Usually classified as aerial lifts, these units provide the same purpose as other scaffolds by elevating a work platform to the required height. OSHA includes the following types of aerial lifts:[10]

- Extensible boom platforms.
- Aerial ladders.
- Articulating boom platforms.
- Vertical towers.
- any combination of the above.

The obvious safety concerns for movable platforms are their limitations to mobility. They are most unsafe while being moved. The need for a level surface, free from obstructions on the ground and overhead, is critical for safe movement. Once in position, it is critical to have a means of securing and stabilizing the scaffold to prevent further movement while workers are on the unit.

## OSHA's Efforts on Scaffolding Safety

OSHA regulations, under 29 CFR 1926.451 (Subpart L), have attempted to limit the risk to workers on scaffolds by specifying safety requirements for them. In the past two decades, no significant changes have been made to the scaffolding regulations (29 CFR 1926.451). Recently, OSHA has reopened its discussion on the scaffolding standards, specifically examining the issue of scaffold stairways, chimney bracket scaffolds and scaffolds used to construct tanks. These areas were an oversight from the last proposed (but not yet implemented) revisions done in 1986.[11] Unfortunately, no final rule has yet

---

[10] 29 CFR Part 1926.556, revised July 1, 1994
[11] "OSHA to Open Record on Scaffold Proposal" *BNA Construction Labor Report*, Jan 12, 1994, v39 p1206

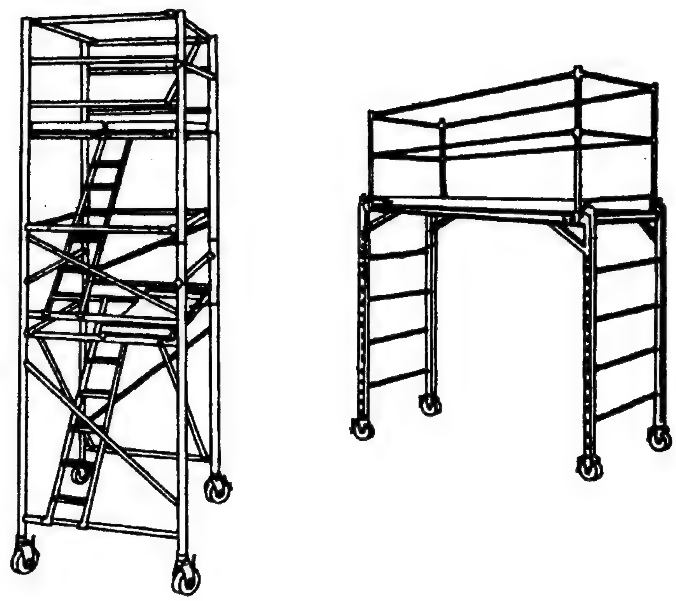

Figure 24: Manually Propelled Mobile Scaffold
(29 CFR 1926.451(e))

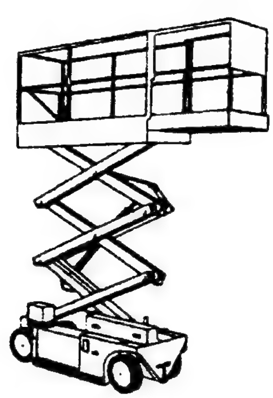

Figure 25: Vertical Tower Aerial Lift
(Scissor Type) (29 CFR 1926.556)

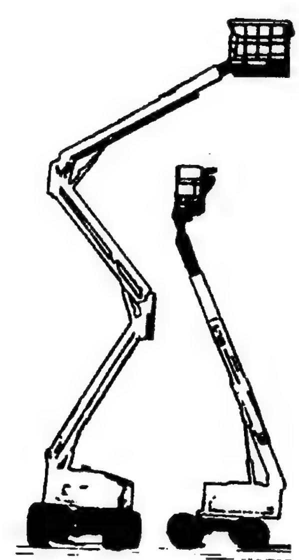

Figure 26: Articulating Boom and
Extensible Boom Aerial Lift Platforms
(29 CFR 1926.556)

been published on any of the proposed changes. On August 9, 1994, a related final rule on fall protection was issued and was to take effect February 6, 1995. During the signing ceremony OSHA administrator, Joseph Dear, stated that the agency was committed to completing a scaffolding standard by the end of 1994.[12] A changed political climate, after the November 1994 elections, has shifted OSHA's focus from this commitment. As a result, OSHA is reassessing its regulatory program in "light of new political realities."[13] It is obvious that more regulations concerning scaffolding is not what a Republican-controlled Congress wants to see.

While the final rule on fall protection may go a long way toward improving construction safety, further modifications of the scaffold standards seem needed. The Denver office of OSHA reported in January 1994 that residential construction had seen a significant rise in the number of fatalities and accidents accompanying the construction boom in the area. Falls were identified as the most common accidents and accounted for the most serious injuries. Barton Chadwick, the OSHA regional administrator, indicated that OSHA regulations are oriented primarily towards commercial construction and not written to address the unique safety concerns of residential construction. The fact that violations of OSHA's fall regulations and scaffolding regulations represented two of three of the largest sources of fines in residential construction in 1992 shows that OSHA has been taking this issue seriously.[14]

Violations of the scaffold regulations are not solely limited to residential construction. A review of nation-wide OSHA violations during the years 1980, 1985, and 1990 showed violations of the scaffold standards ranking first, second and fourth, respectively, based on

---

[12]"OSHA Issues Final Fall Protection Standard..." *BNA Construction Labor Report*, Aug 10, 1994, v40 p585

[13]"Dear Says OSHA Examining Job Safety..." *BNA Construction Labor Report*, Dec 7, 1994, v40 p958

[14]"Denver-Area Residential Boom ..." *BNA Construction Labor Report*, Jan 12, 1994, v39 p1208

total number of violations.[15] Another study examined violations issued from 1985 to 1994 and found scaffold violations ranked third in total violations and second in serious violations. This study found 80.8% of the violations involving scaffold standards classified as serious.[16] With such a significant ranking, it is no wonder that OSHA is taking a more serious stand against violators. In the 1992 case of *Secretary of Labor v. R.G. Friday Masonry Inc.*, Judge Schoenfeld cited the company for repeat scaffold violations and lack of good faith concern for employee safety doubling the OSHA proposed penalties to $35,000.[17] No injuries were involved with these violations but merely were due to the lack of guardrails and toeboards on scaffolding used at two job sites. It is clear that action such as this will send a signal to employers that violations, especially repeat violations, will not be tolerated.

The importance of following the standards was further emphasized under *Secretary of Labor v. Pyramid Masonry Contractors Inc.*[18] In this case, the court ruled that the Secretary need not prove that a hazard exists, only that non-compliance of the standard exists because the cited standard "presumes the existence of a hazard when its terms are not met." This is exactly what the National Institute for Occupational Safety and Health (NIOSH) found in a survey of fall-related deaths from 1980 to 1985.[19] Defective scaffold equipment and the improper installation or operation of scaffolding were identified to be the most significant violations of the standards attributable to scaffold fatalities. This indicates that the blame is on the lack of adherence, not the standards. The editor of *Fine Homebuilding* admitted "As a carpenter, I never read OSHA's standards for scaffolding.

---

[15] Hinze, J. and Russell, D., "Analysis of Fatalities Recorded by OSHA", *J. of Construction Engineering and Management*, ASCE, Vol 121, No. 2, June 1995, p209

[16] Hinze, J. and Bren, K. "Identifying Construction Areas of Need for Safety Research," *J. of Construction Engineering and Management*, ASCE, Vol 122, No.1, (to be published)

[17] "Judge Doubles Proposed Penalties..." *BNA Construction Labor Report*, Sept 9, 1992, v38 p725

[18] OSHRC, No. 91-0600, 11/4/93, as cited in "Labor Secretary Need Not Prove Hazard..." *BNA Construction Labor Report*, Nov 17, 1993, v39 p1018

[19] NIOSH Alert No. 92-108, as cited in "Scaffold Falls Could Be Prevented..." *BNA Construction Labor Report*, Feb. 10, 1993, v38 p1417

As an editor preparing an article on scaffolding for publication, I had to read them. ...they make me aware that I've taken some foolish chances with scaffolding that I've built."[20]

**Liability for Scaffolding Accidents**

With large numbers of violations and injuries being sustained, who is being held liable for any wrong doing? Liability has plagued the construction industry for many years. The oldest written building code dating to 2200 BC from Babylonia specified: "If a builder build(s) a house for a man and do(es) not make its construction firm and the house which he has built collapse(s) and cause(s) the death of the owner of the house - that builder shall be put to death."[21] While undoubtedly a harsh punishment, it dramatizes the seriousness of the issue. In the case of temporary structures the construction worker, rather than the owner, is the party put at risk. The concept of liability, however, remains the same. A number of factors can be involved when determining liability for temporary structures. First to consider is whether the structure failed by design or was not constructed properly. The designer of a facility assumes a great deal of responsibility should failure occur. Two options exist for design of scaffolds or temporary structures in general: owner-provided design or contractor-provided design.[22]

Under an owner-provided scaffold design, the contractor could be relieved of liability if the temporary structure was constructed "as specified" and subsequent failure occurred. The term owner refers to a collective position with an architect/engineer actually performing the design. By the owner assuming the design responsibility for the temporary structure greater assurance is provided that the structure has received a proper design.

---

[20]Ireton, K. ed. "Scaffolding - What Goes Up Mustn't Come Down Accidentally", *Fine Homebuilding*, Dec-Jan 1987, n36 p37

[21]Helander, M. ed., *Human Factors/Ergonomics for Building and Construction*, New York: Wiley, 1981, p40

[22]Smith, R.J., "Contractual and Legal Considerations With Respect to Temporary Structures" *Temporary Structures in Construction Operations*. Ed. R.T. Ratay, New York: American Society of Civil Engineers, 1987, p9-12.

"Owner-provided" designs are typical for complex temporary structures (structures as may be required for special construction such as tunneling), but this is not normally done for typical scaffolding requirements. Under contractor-provided design, the owner has the option to review and approve the plans for the temporary structure. Normally the contractor assumes more responsibility but the owner may share in this responsibility by participating in the review and approval process. With the availability of pre-engineered scaffolds and the specific standards concerning their use, the design of scaffolds is typically left to the contractor without much involvement by the owner.

**Owner Liability**

As mentioned earlier, most violations and injuries result from defective equipment and improper installation or operation. This usually points the liability away from the owner/designer and towards the contractor. The issue then revolves around who was in charge of the work/area. Again, this usually eliminates the owner/designer. An exception is noted in the 1980 case of *Emberton v. State Farm Mutual Automobile Insurance Co.*[23] in which an employee of the general contractor was injured while moving a portable scaffold. He sued the owner and architect and the court found evidence that the owner had sufficient "charge of" the work due to their particularly detailed involvement in the construction process. Usually an owner is removed of this involvement by the contractual arrangement with the general contractor. However, the test of who is "in charge" of the work usually becomes more important than contract language.

**Designer Liability**

The architect/engineer is likewise often eliminated from the responsibility for safety because of the contract clauses giving "charge of" the work and responsibility for safety to the general contractor. A number of cases have been brought against architect/engineers

---

[23] 44 Ill. App. 3d 839, 358 N.E.2d 1254 (1976), rev'd. 71 Ill. 2d 111, 373 N.E.2d 1348 (1978), further proceedings, 85 Ill. App. 3d 247, 406 N.E.2d 218 (1980)

claiming they had a responsibility to ensure the safety of the job site.[24] Most decisions boil down to the language of responsibilities in the architect/engineer's contract with the owner which specify inspection of progress and quality of work. While the courts have continued to relieve the architect/engineer of liability, lawyer and architect, Arthur Kornblut, has warned designers of the potential liability of one particular situation. What if unsafe conditions are observed or brought to the designer's attention when at a job site inspecting or reviewing the construction progress? Such information cannot be ignored by the architect/engineer. Professional ethics would dictate that action should be taken by the architect/engineer, with the owner or general contractor, to remedy the condition.[25] This sentiment was also echoed by lawyer, Kenneth I. Levin, stating "...courts have inferred from provisions vesting a professional with the right to stop the work a corresponding duty to exercise care to prevent contractors from employing unsafe practices."[26]

**Contractor Liability**

Liability usually rests with the general contractor. According to the Occupational Safety and Health Act, the general contractor as an employer, "(1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees" and "(2) shall comply with occupational safety and health standards promulgated under this chapter." Even though "recognized hazards" may pose a potential loophole from liability, watchdogs, primarily in the form of OSHA compliance officers, help keep the general contractor appraised of these hazards. The second clause has been interpreted as requiring compliance with OSHA standards by the employer in "charge of" the work area where the hazard exists.[27]

---

[24] *Construction Industry Contracts: Legal Citator and Case Digest*. New York: Wiley, 1988, pp.462-470
[25] "Legal Perspectives: Who is Liable for Construction Safety" *Architectural Record*, October 1983, p41
[26] Levin, K. I. et al. *Construction Litigation*. New York: Practicing Law Institute, 1993, p309
[27] Howell, Lembhard G., "Construction Site Accidents: How OSHA Affects their Litigation" *Trial*, March 1985, p18-23

For a multi-employer construction site, identifying the party in "charge of" the work area can be confusing. Can a general contractor be liable for violations or injuries caused or controlled by subcontractors? Two similar cases involving subcontractors' employees injured when falling from scaffolding address this situation with dissimilar outcomes. Under *Hand v. Rorick Construction Co.*[28] the Nebraska court found that the general contractor had no control over the equipment used by the subcontractor and held the general contractor not liable. Under *Stepanek v. Kober Construction Co.*[29] the Montana court found the general contractor liable due to contract language with the County stating that the general contractor could not delegate responsibility for safety to the subcontractor.

Consider the case of *Plan-Tec, Inc. v. Wiggins.*[30] A construction manager was held liable for a subcontractor's employee's injuries when a scaffold collapsed. Even though the construction manager's contract with the owner imposed no responsibility for project safety the absence of a general contractor in the project hierarchy caused the construction manager to assume some functions of the general contractor. While this assumption of some duties did not make the construction manager liable for safety, his action of inspecting the scaffolding and other safety related functions did.

OSHA is taking the position of holding the general contractor, as well as the subcontractor, liable for violations of standards committed by subcontractors.[31] Under *A/C Electrical Co. v. OSHRC*,[32] the subcontractor, A/C Electric Co., and the general contractor were cited for a violation involving the subcontractor's employee working on a substandard scaffold. The subcontractor argued that since the employee was directed by

---

[28] 100 Neb. 191, 206 N.W.2d 834 (1973)
[29] 625 P.2d 51 (Mont. 1981)
[30] 443 N.E.2d 1212 (Ind. Ct. App. 1983)
[31] "Subcontractor at Multi-Employer Site..." *BNA Construction Labor Report*, Jan 15, 1992, v37 p1222
[32] US Ct. App. CA 6, No. 91-3366, 12/20/91 as cited by "Subcontractor at Multi-Employer Site..." *BNA Construction Labor Report*, Jan 15, 1992, v37 p1222

the general contractor to work on the scaffold they should not be liable for the employee's misconduct. The court upheld the citation stating that the subcontractor did not properly instruct the employee regarding scaffold safety. It is important to note that even though there is a trend to hold the general contractor liable for accidents and violations of code, this does not necessarily relieve subcontractor's of their responsibility for safety.

One interesting case was found where an attempt was made to shift the liability to the scaffold supplier[33]. A worker was injured when he slipped and fell off of the scaffolding. Under *Ball v. SGB Construction Services*,[34] the Texas court found the supplier not responsible citing evidence that the supplier even provided an instruction manual on the proper erection of the scaffold. It was not clear whether the manual had been followed or if the accident occurred during erection. This supplier, however, was acting professionally and pro-actively by going beyond normal expectations to provide the erection manual.

## Summary

The purpose of scaffolding, to raise a work platform with minimal materials and effort, creates the inherent risk associated with its use. Workers not familiar with scaffolding regulations put themselves at considerable risk when using scaffolds when they do not recognize unsafe situations. The variety of scaffold styles available, while intended to make the work platform safer for specific uses, can create hazards when a particular type is not used for its intended purpose. These factors can lead to disaster unless particular attention is paid to scaffolding safety. The most common causes of scaffold accidents cited by previous studies related to a simple lack of adherence to the regulations.

---

[33]"Scaffold Supplier Not Liable..." *BNA Construction Labor Report*, Dec. 18, 1991, v37 p1129
[34]Texas Ct. App. , No. 01-91-00224-CV, 11/21/91 as cited by "Scaffold Supplier Not Liable..." *BNA Construction Labor Report*, Dec. 18, 1991, v37 p1129

Efforts by OSHA to limit scaffold accidents have lead to tougher enforcement of scaffold regulations and higher fines for repeat offenders. No party seems to be totally immune from liability for safety on the construction site. The potential for liability should further emphasize the importance of accident prevention. Rather than trying to seek contractual ways to avoid responsibility for project safety, the contracting parties should focus on the overall prevention of injuries. Owners and designers, instead of transferring safety responsibility solely to the general contractor, should play an integral role with the general contractor and subcontractors to ensure safety with temporary structures. General contractors need to work closely with subcontractors to ensure a commitment to safety exists with all personnel on the job site. The long range benefit may be finishing the project without delays caused by accidents. OSHA should consider a more proactive stand to improve compliance with standards. With increased political pressure to reduce or eliminate regulations, OSHA would be better served by investing in methods to improve compliance with existing regulations rather than creating new ones. Hopefully, with increased emphasis on prevention, the likelihood of accidents and litigation arising from injuries should dramatically decrease.

# Chapter 2
# Research Methodology

## Research Objectives

The main objective of this research is to obtain information by which reductions may be made in construction scaffolding and floor/wall opening accidents. This information will be generated through the examination of the circumstances associated with past injury accidents. By better understanding the causes of past accidents the probability of reducing future accidents should improve. The trends and significant causes identified from historical data will hopefully prove useful in modifying Federal or local safety regulations or be used in safety educational materials. The results of this research can make people more aware of the most common types of causes of these accidents and they can then take measures to mitigate them.

Wall and floor openings were included with scaffolding in this research because of the similarity between the two construction situations. Specifically, both can make use of guardrail systems or lifelines to provide the necessary fall protection. Additionally, wall and floor openings are often associated with scaffolds and can be present on the scaffold itself. In general, this research examines the safety of work platforms whether raised by a scaffold system or existing on a structure without adequate enclosures for fall protection.

## Research Data

The accident data used was obtained from the Occupational Safety and Health Administration's Office of Management Data System's Integrated Management Information System (IMIS) database. This database contains accident information reported to OSHA since 1985 and contains 56 fields of information in addition to an abstract describing each accident. A sample of the IMIS printout is included in Appendix A. This data is collected from Investigation Summaries, OSHA-170, used by investigators to summarize the results of "events involving fatalities, catastrophes, amputations and

hospitalizations of two or more days; events which have generated significant publicity; and events resulting in significant property damage."[35]

**Research Approach**

The database was searched for accidents occurring between January 1985 to January 1995 involving the words scaffold, aerial lift, wall opening, or floor opening. This generated a listing of 760 cases which were screened for applicability to scaffolds, aerial lifts, wall openings or floor openings. Accident cases which did not directly involve these items surfaced in the listing from the abstract description and were not included in the final analysis. For example, a worker may have been injured by a forklift after climbing down the scaffold en route to the site office. Since the scaffold had nothing to do with the injury the case was not considered.

The database was also searched for all cases involving citations of 29 CFR 451 (Subpart L- Scaffolding), 500 (Subpart M- Floor and Wall Openings) and 556 (under Subpart N for Aerial Lifts). This generated a listing of 730 cases, many of which were duplicated from the previous listing. This search did, however, generate new cases which involved scaffolds, aerial lifts, wall openings or floor openings but did not use these words in the abstract description.

The results of this second search did give cause to be a little suspicious of the IMIS database program. Many cases were found in this second listing which included the correct wording in the abstract and, therefore, should have been included in the first listing, but were not. While this discrepancy brings into question the accuracy of the information from the IMIS, considerable information was still deemed valuable. The dual search strategy provided a worthwhile check on the extent of coverage as nearly 40% duplicate cases were found.

---

[35] OSHA Instruction Manual ADM 1-1.31 dtd Sept. 20, 1993, p.XXIX-1

**Database Structure**

The information obtained from the IMIS was reassembled into a statistical database, within the Statistical Package for the Social Sciences (SPSS). The structure of this database, its coding of information, and sample of coded information are included in Appendix B. The basic information used includes the following:

| | |
|---|---|
| Case Number | : Used as a quick identification for cases. |
| Summary Number | : OSHA number identifying case from IMIS. |
| Time, Month, Year | : Time, month, and year of the incident. |
| State, OSHA Region | : State and OSHA region of incident location. |
| Fine | : Amount paid for CFR violations. |
| Union | : Union or non-union affiliation of the company/project. |
| Company/Jobsite Size | : Number of employees involved. |
| Use of scaffolding | : How scaffolding was being used at time of incident. |
| SIC | : Standard Industry Codes for work being performed. |
| Elevation | : Height, in feet, of work platform. |
| Scaffold Type | : Scaffold types as defined by 29 CFR 451. |
| Opening Size | : Rough area of wall or floor openings. |
| Weather | : Weather at time of the incident. |
| Causes | : Apparent causes of incident. |
| Injured Worker Data | : Number, age, disposition, type of injury, and body part injured. |
| CFR Violations | : Paragraph citation and characterization of severity. |

Many datafields involved facts which were extracted directly from the IMIS information and did not require any interpretation. However, more specific information relating to the causes of each accident was obtained from the abstract description in which details of the incident varied greatly from case to case. Causal information obtained from the abstracts is more detailed than causal factors used by OSHA's coded choices established for their Investigation Summary form. The database was organized to be able to compare OSHA's

coding of the causes to the researcher's interpretation of the information available in the abstract description.

### Data Analysis

The data were analyzed by examining the general characteristics of the accidents and, subsequently, proceeding to more specific issues as factors of interest were identified from the general analysis. Case variables were compared on the basis of timing, location, job site, company, and victim characteristics prior to proceeding to more specific comparisons of individual scaffold types. Basic histograms and tables were utilized to isolate unique aspects of fatality cases, including specific information provided in scaffold and floor/wall opening cases.

This analysis was not intended to follow a rigorous statistical methodology. The nature of the data and the lack of reliance that the data accurately represents all scaffold and floor/wall opening cases in the U.S. from 1985 to 1994 does not lend itself to analysis by complex statistical procedures. Rather, the results are represented in simple comparative form in order to gain insight into the characteristics surrounding these accidents.

# Chapter 3
## Analysis and Results

Of the 1030 cases recorded, 654 involved fatalities, 376 were injury-only involving either a hospitalized or non-hospitalized injury and 104 involved both fatalities and injuries (see Figure 27). The fatality cases accounted for 669 total deaths in which 12 cases involved 2 or more fatalities. Hospitalized injuries (injuries involving hospitalization) totaled 518 workers and non-hospitalized injuries totaled 126 workers. Multiple injuries per case were more common than multiple fatalities with 77 cases counting 2 or more hospitalized victims. While cases did involve combinations of fatalities and injuries, 83.3% involved only one victim.

Scaffold-related accidents accounted for 670 cases. Floor and wall opening accidents accounted for 394 cases. Of these numbers, 34 cases were counted in each category as they consisted of accidents in which both scaffolds and openings were involved (see Figure 28). Single victims accounted for 97.7% of the floor and wall opening cases and 75.3% of the scaffold cases. Fatalities accounted for 73.4% of the floor and wall opening cases and 57.8% of the scaffold cases. These general statistics are summarized in Table 1.

### Timing of Accidents

The time of day was recorded in 2400 hour time and was categorized into hour segments with the exception of night hours. The time of the incident was provided for only 277 out of 1030 cases. Incidents generally occurred during daylight hours as shown in Figure 29. The frequency of cases rose significantly after the start of the regular work day hours to peak around the 0900 to 1000 period, dipped during the noon hour and rose again in the early afternoon hours to peak again between 1300 to 1400. No significant difference is noticed between the time of fatality cases to injury-only cases. The distribution of accident occurrences is similar to the distributions generally observed in construction data from other studies.[36]

---

[36] Hinze, J., *Construction Safety,* (to be published), p28

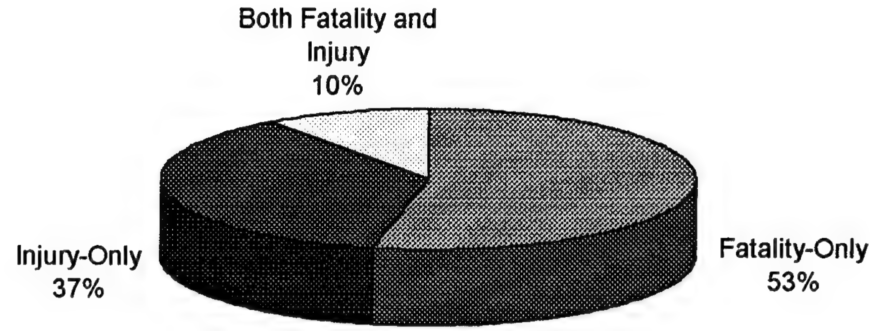


Figure 27: Accidents by Disposition of Victims

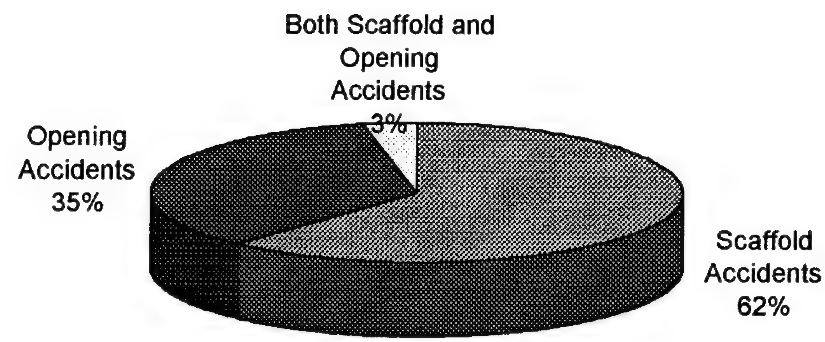


Figure 28: Accidents by Scaffold or Floor/Wall Openings

Table 1: General Scaffold and Opening Accident Statistics

| | Scaffold Cases | Opening Cases |
|---|---|---|
| Accidents | 670 | 394 |
| Fatality Cases | 57.8% | 73.4% |
| Single Victim Cases | 75.3% | 97.7% |
| Total Fatalities | 401 | 290 |

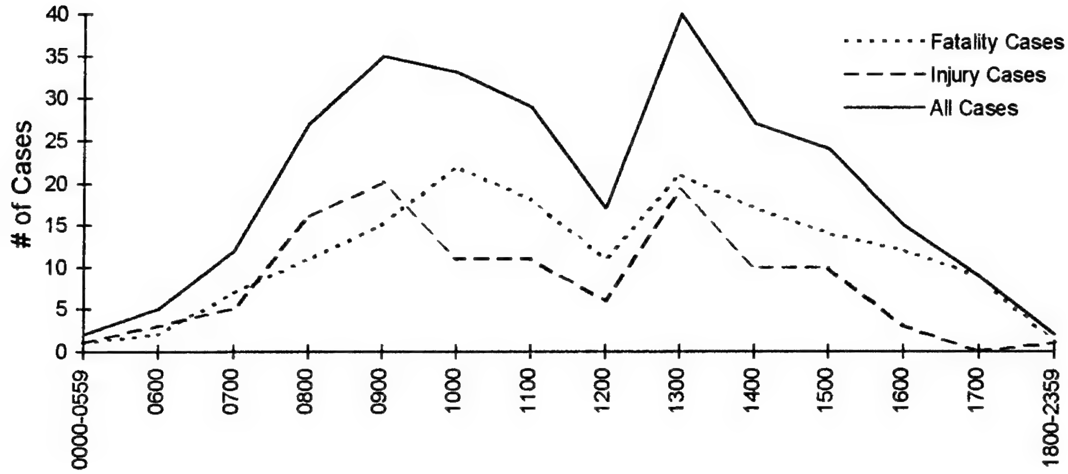


Figure 29: Cases by Time of Day

Cases were also recorded with the month of the occurrence with data being provided for all cases. The summer months were significantly higher in the number of incidents, particularly due to an increase in fatality cases, as shown in Figure 30. Injury-only cases increased only slightly during the summer months. This rise in the frequency of accidents during the summer corresponds to the increased construction activity for this season, as documented in the 1987 census of the construction industy.[37] The most surprising information is the sharp rise in fatalities and injuries during the month of October.

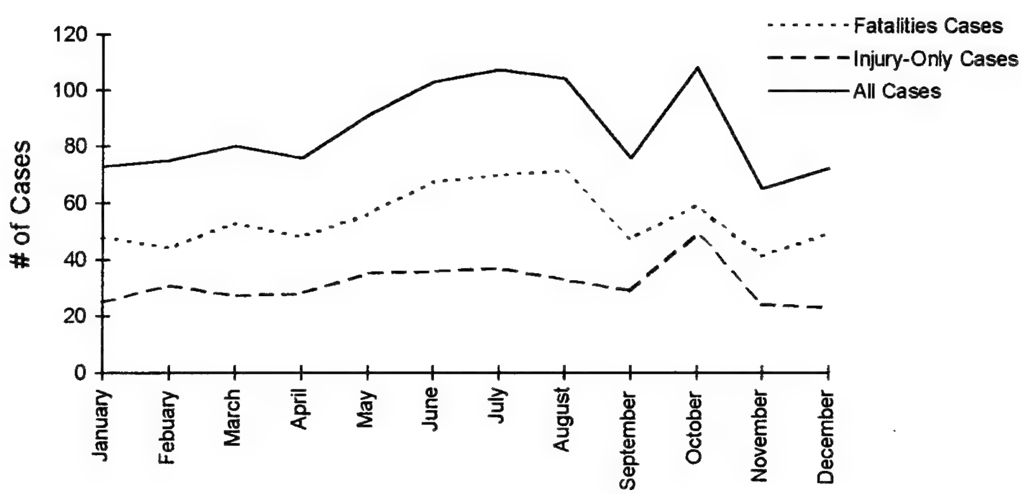


Figure 30: Cases by Month of the Year

[37] *1987 Census of Construction Industries*, US Dept. of Commerce, CC87-A-10, issued Oct. 1990

One consideration is that this phenomenon is related to the dramatic changes in weather experienced during this month. This might be expected to occur, only or to a larger extent, in the northern climates where the temperature and weather changes are most dramatic in October, however, this was not confirmed by the comparison made between northern and southern states (see Figure 31). Northern regions showed a slight October peak which was lower than the frequencies recorded during the summer months. Southern regions showed the largest increase in October in contrast to what would have been expected if weather was the influencing factor.

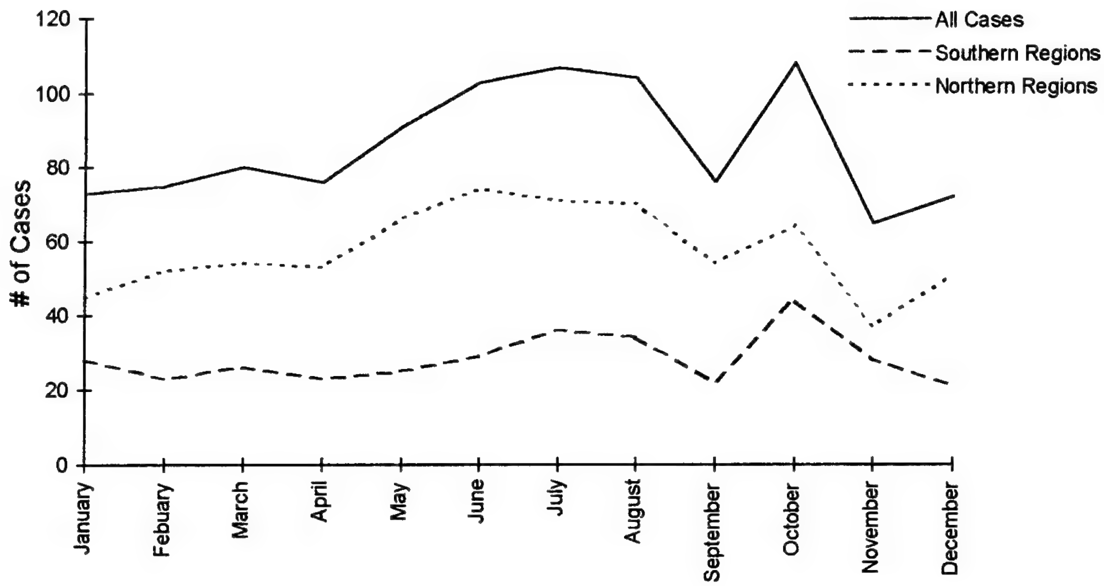


Figure 31: Cases by Month and by Region of Country

Figure 31 shows a more pronounced spike in October for southern states than for the northern. Either the phenomenon is related to other factors, or too little data is available from all states to accurately test for this possibility. When the comparison is made for only fatality cases the southern regions show an interesting increase with the overall number of fatality cases, as shown in Figure 32. The dramatic spike for October is now somewhat de-emphasized in contrast to the apparent slump in fatality cases for September. Northern region fatality cases show what might be expected - a gradual build-up over the

summer months, typically the most active construction period as seen from the 1987 census data.

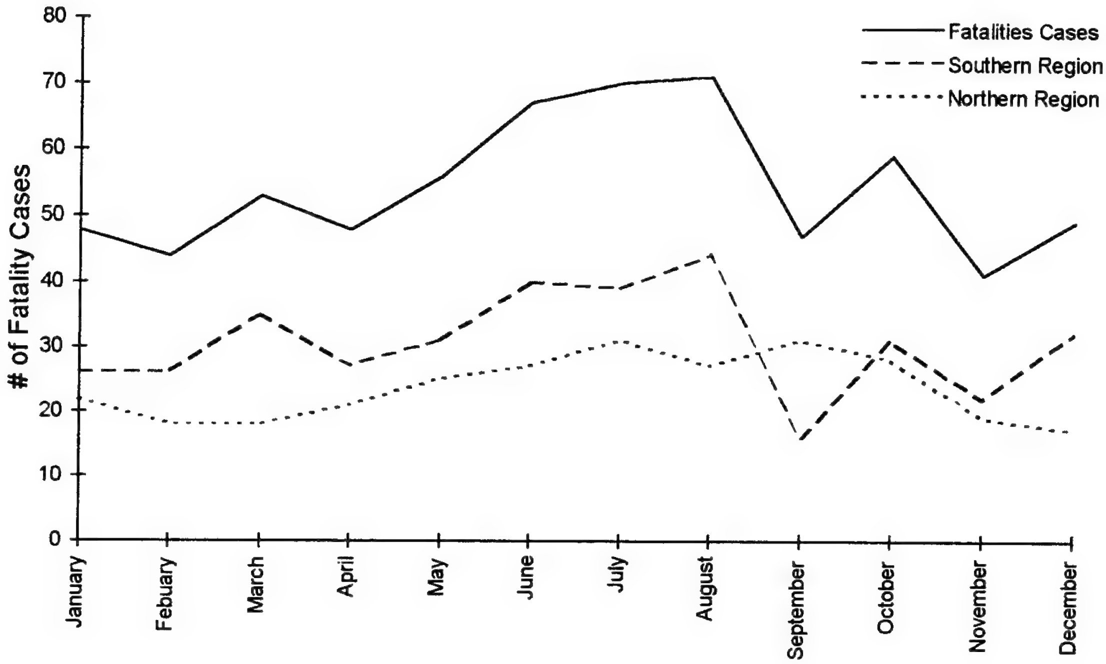


Figure 32: Fatality Cases by Month and Region of Country

Yearly data seems to show a significant decline since the start of the IMIS database in 1985, as shown in Figure 33. The dramatic decrease seen since 1988/89 is remarkable and calls into question the accuracy of the IMIS database in reporting a complete picture of accidents of any nature. No significant event in 1988/89 was discovered which might explain this trend. When the number of states reporting per year is compared the same dramatic decrease is seen after 1989, as shown in Figure 34. A comparison was also made with states holding their own independent plan implementing the Occupational Safety and Health Act requirements commonly referred to as “state-plan” states. The decrease in reporting occurs even with state-plan states and, therefore, likely not entirely due to this difference in the states. If the state data is examined further, only 15 states reported cases for more than half of the years between 1985 and 1994. Only 6 of these 15 are state-plan states. Not surprisingly, these 15 are the states typically reporting after 1989. More detailed state data and analysis will be presented in the next section.

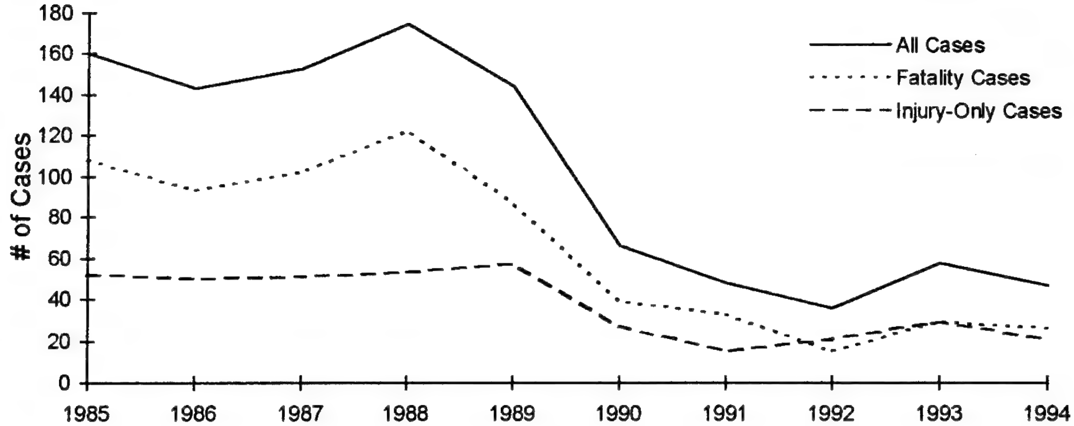


Figure 33: Cases by Year

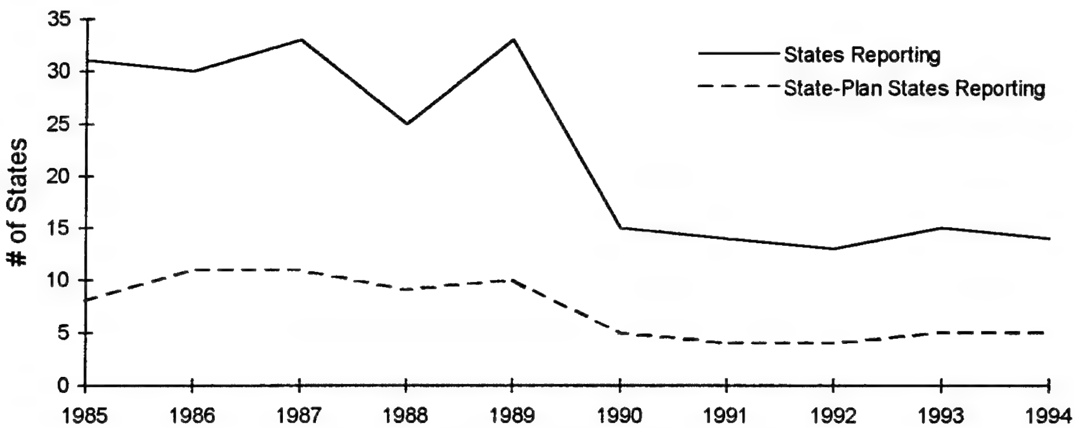


Figure 34: Number of States Reporting by Year

**Locations of Cases**

The location (state and OSHA region) of the fatality/injury occurrences was provided for all cases. No cases, however, were reported from Alaska, Hawaii, Michigan, Utah, Vermont, Washington, and Wyoming. The number of cases reported by the remaining states varied greatly from Maryland reporting the most cases at 195 to many states reporting only a few cases during the period. State fatality data, reported over 3 or more years, is presented in Table 2 and shows fatalities normalized over the years reported and adjusted per million workers on payroll. The number of construction workers per state is based on the 1987 Census of the Construction Industry which provided information on the

Table 2: State Fatalities Recorded

| State | Number of Years Reporting btwn 1985-94 | Construction workers on payroll in 1987* | Fatalities Recorded btwn 1985-94 | Fatalities per 1 million workers per year |
|---|---|---|---|---|
| Dist. of Columbia | 4 | 198,000 | 7 | 8.84 |
| Idaho | 4 | 184,000 | 5 | 6.79 |
| Mississippi | 7 | 391,000 | 9 | 3.29 |
| Oklahoma | 3 | 531,000 | 5 | 3.14 |
| Rhode Island | 7 | 337,000 | 6 | 2.54 |
| Colorado | 5 | 1,154,000 | 14 | 2.43 |
| Texas | 5 | 5,038,000 | 56 | 2.22 |
| Kansas | 4 | 701,000 | 6 | 2.14 |
| Illinois | 5 | 4,038,000 | 43 | 2.13 |
| Alabama | 6 | 1,207,000 | 15 | 2.07 |
| Indiana** | 5 | 1,609,000 | 15 | 1.86 |
| New Hampshire | 4 | 554,000 | 4 | 1.81 |
| Minnesota** | 4 | 1,544,000 | 11 | 1.78 |
| Virginia** | 10 | 2,264,000 | 37 | 1.63 |
| South Carolina** | 8 | 1,315,000 | 17 | 1.62 |
| Ohio | 5 | 3,011,000 | 24 | 1.59 |
| Maryland** | 10 | 2,389,000 | 37 | 1.55 |
| Florida | 10 | 4,070,000 | 60 | 1.47 |
| North Carolina** | 10 | 1,915,000 | 26 | 1.36 |
| Maine | 3 | 489,000 | 2 | 1.36 |
| Kentucky** | 10 | 759,000 | 10 | 1.32 |
| Wisconsin | 3 | 1,317,000 | 5 | 1.27 |
| Georgia | 9 | 1,973,000 | 22 | 1.24 |
| Missouri | 5 | 1,796,000 | 11 | 1.22 |
| Tennessee** | 5 | 1,341,000 | 8 | 1.19 |
| New York | 10 | 6,006,000 | 66 | 1.10 |
| New Jersey | 10 | 3,363,000 | 35 | 1.04 |
| Massachusetts | 9 | 2,467,000 | 23 | 1.04 |
| Pennsylvania | 10 | 3,989,000 | 41 | 1.03 |
| Louisiana | 3 | 1,127,000 | 3 | 0.89 |
| Connecticut | 9 | 1,588,000 | 11 | 0.77 |
| Arizona** | 5 | 1,366,000 | 5 | 0.73 |
| Iowa** | 3 | 546,000 | 1 | 0.61 |
| Nevada** | 3 | 585,000 | 1 | 0.57 |

*1987 Census of Construction Industries, US Dept. of Commerce

**State-Plan States

payroll for each state. The assumption was made that this count has remained relatively steady between 1985 to 1994.[38] Inconsistencies in reporting may be related to states holding their own independent plan implementing the Occupational Safety and Health Act requirements. Currently, 21 states are operating under their own "state plan" with oversight conducted by OSHA.[39] While many state-plan states report on a regular basis only 11 are represented in Table 2 and 62.5% of the states reporting fewer than 3 years are state-plan states. A complete listing of "state-plan" states and OSHA regions is included in Appendix C.

Examining the fatalities by OSHA regions indicates a large portion represented by the eastern US, as shown in Figure 35. In particular, the Mid-Atlantic region is especially high in total injuries and the South East region is high in fatalities. This high frequency may be due to the regular reporting activities of the states of Maryland, Virginia, Florida and North Carolina. If the cases are normalized per million construction workers, based on the 1987 statistics mentioned earlier, the significance of the number of injuries and fatalities in the east is diminished in light of the high fatality ratios for Idaho, Mississippi, Oklahoma, Colorado, and Texas.

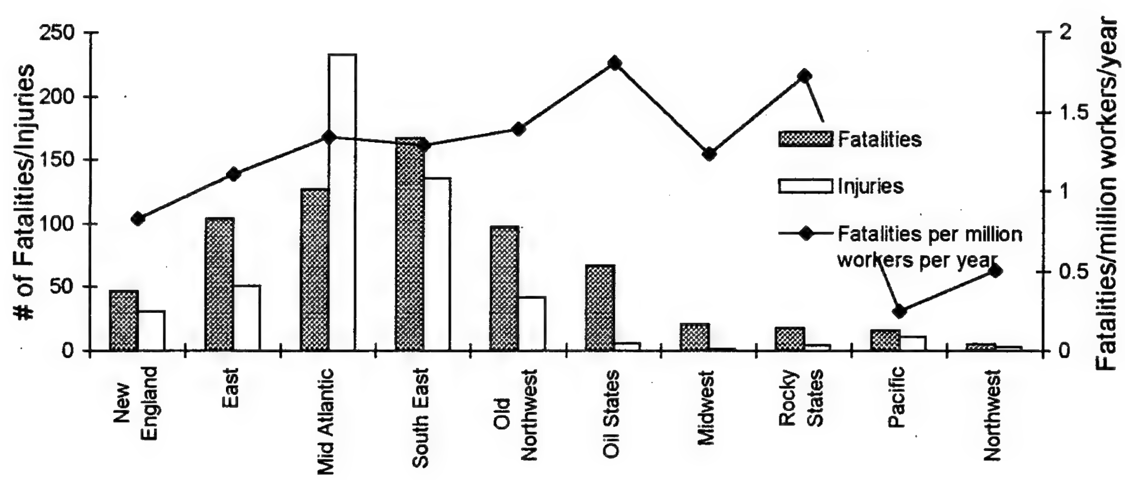


Figure 35: Cases by OSHA Region

[38] *1987 Census of Construction Industries*, US Dept. of Commerce, CC87-A-10, issued Oct. 1990

[39] Hinze, J., *Construction Contracts*, New York-McGraw-Hill, 1993, p.311

**Job Site Characteristics**

Company size, union affiliations, fines paid and the type of construction operation were recorded and can be used to characterize the type of job sites and companies involved with the cases. The cases were almost exclusively private sector companies with only four cases recorded as government organizations. Company sizes varied from a high of one case at 5000 employees to 5 cases recorded with no employees. The average size was 39 employees. However, the median size was 8 employees. As shown by Figure 36, the cases were dominated by small companies. This does seem to indicate that small companies either have poorer safety programs or that smaller firms occur in greater numbers in the construction industry. The percent of fatality cases seems to increase with company size indicating that of the few times large companies have an accident it is more likely to be a case involving a fatality.

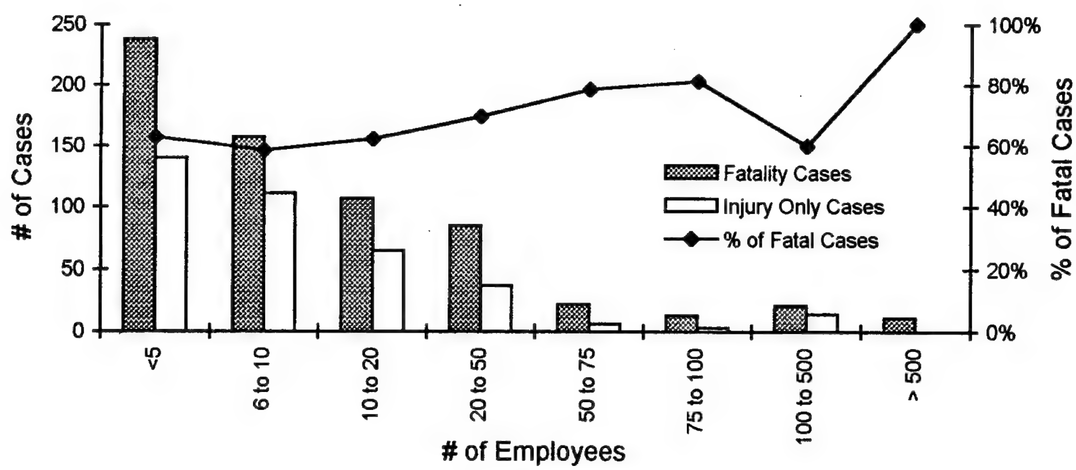


Figure 36: Cases by Company Size

When company sizes were compared specifically to scaffolding or opening cases a similar predominance with smaller companies is found, as shown in Figure 37. The ratio of scaffold to opening cases in each size category indicate, possibly, that larger companies are better prepared at erecting and using scaffolding safely. The relative frequency of residential construction followed a similar trend as indicated in Figure 37. Of the 110

cases related to residential construction 97 involved companies with fewer than 10 employees.


Figure 37: Scaffold and Opening Cases by Company Size

When company size was compared to the average citation fine paid per incident, the smallest companies paid less than most larger companies, as shown in Figure 38. A notable exception is seen for companies sized between 10 and 20 employees which paid more on average than all other sizes except companies with 100 to 500 employees. Considering that half of the cases involved were represented by companies with fewer than 8 employees, the data indicates that larger companies may have more serious accidents. However, if a serious accident can be defined as a case involving a fatality, again as seen in Figure 34, companies with fewer than 8 employees accounted for half of all fatality cases. Another possibility for this data is that OSHA (at the federal or state level) is, consciously or unconsciously, not assessing large fines on smaller companies.


Figure 38: Average Fines Paid by Company Size

Examining fines for all cases, a surprising 17.5% of the cases were not assessed any fine. The expectation would be that these zero fine cases were minor injuries, however, 61% of the cases with no fines assessed involved fatalities, as shown by Figure 39. Four cases involved fines in excess of $100,000 of which all were fatalities. The median fine for all cases was $560. The median fine for fatality cases increased slightly to $645, while injury-only cases had a median of $400. Interestingly, there was no difference between scaffold cases or opening cases, each with a median of $560.

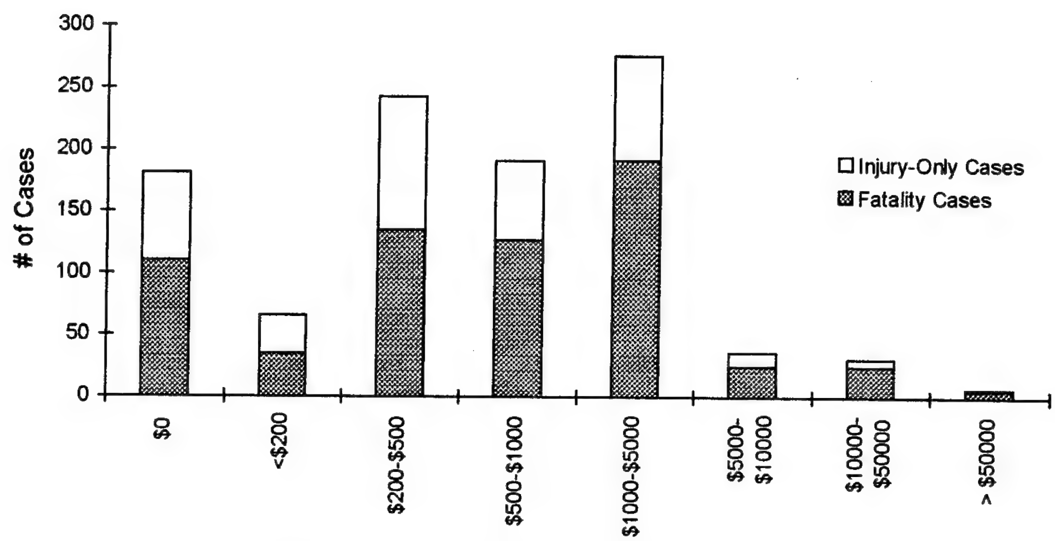


Figure 39: Cases by Citation Fines Paid

Union affiliation of the job sites was recorded for all cases and percentages varied slightly from the 1994 national construction industry average of 19.9% union, as reported by the Labor Department's Bureau of Labor Statistics.[40] Union affiliations accounted for 25.2% of all cases recorded, as shown in Figure 40. Note that union affiliation was considered to exist when there was at least one worker on the project working under a labor agreement.

[40] "Construction Union Membership...", *BNA Construction Labor Report*, Vol. 40, No. 2018, Feb. 15, 1995, p1237

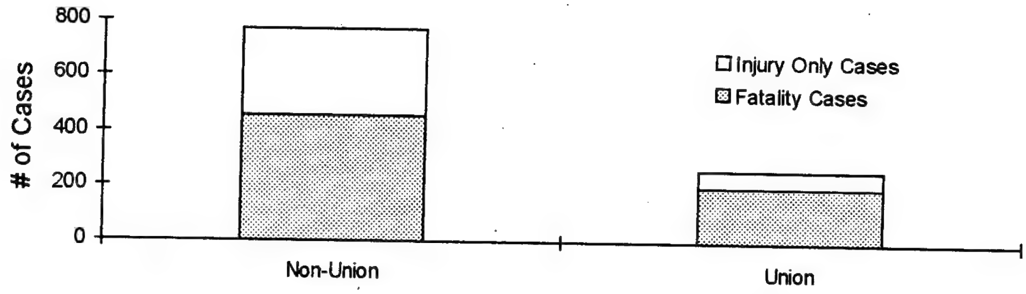


Figure 40: Cases by Job Site Union Affiliation

Standard Industrial Codes (SIC's) were recorded for all cases as assigned by the OSHA compliance officers. An additional classification of the construction operation was recorded from information presented in the abstract for each case. The Special Trade Contractors category (code 17XX) accounted for 74% of all the cases. The secondary coding based on the abstract information matched the SIC coding fairly well with only a few exceptions attributed to the vagueness of the abstract descriptions. The distribution for all cases codes distinguished 2 categories as being more prevalent than the others (see Figure 41). Code 174; masonry, stonework, and plastering; accounted for 20% of the cases. Code 1761; roofing, siding, and sheetmetal work; accounted for an additional 14.8%. When examining fatality cases, code 1761 accounted for the most cases at 16.8%, but by not as large a margin. Injury cases continue to dominate in the 174 category. A complete listing of SIC descriptions is included in Appendix D.

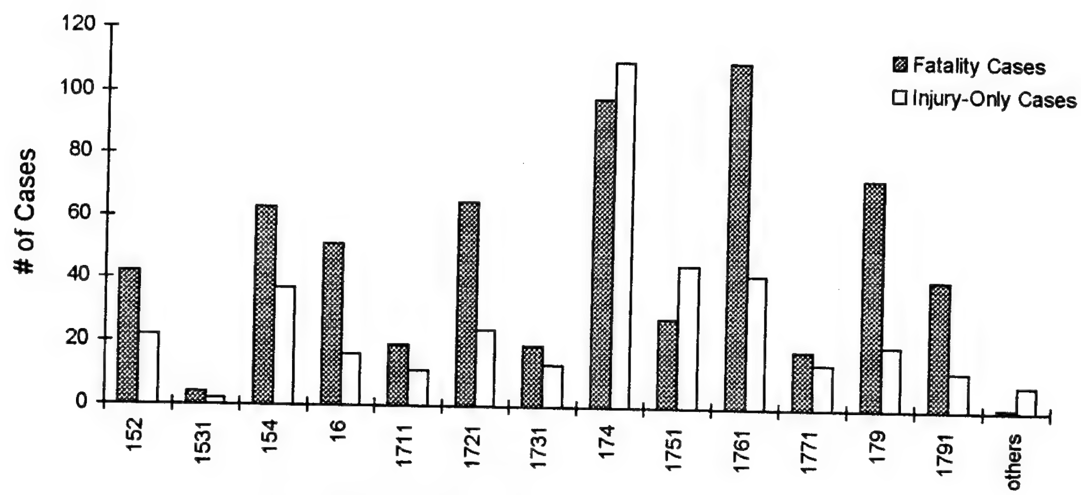


Figure 41: Cases by Standard Industrial Code

When the cases are separated by scaffold and opening accidents, the reason for masonry (174) and roofing (1761) operations predominance becomes clearer. Code 174 accounts for 28.8% of the scaffolding accidents followed by code 1721, painting (12.5%), and 1790, micellaneous specialty trades (11.2%). Code 1761 accounts for 28.7% of the opening accidents followed by 154, non-residential building construction (11.4%) and 1751, carpentry work (9.4%) (see Figure 42). By understanding the significant role scaffolding plays in masonry work, it is little wonder that accidents may tend to be more common in this category. Likewise, the hazards of openings are more acute during roofing operations than operations performed by most other trades.

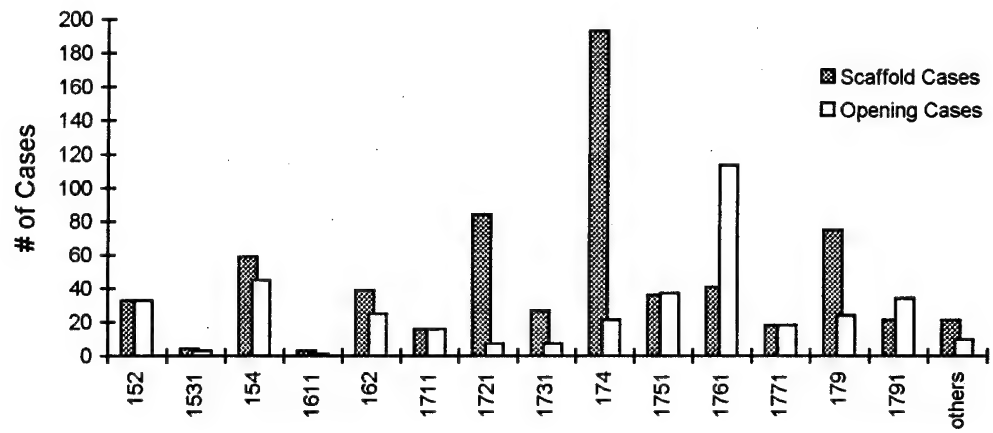


Figure 42: Scaffold/Opening Cases by Standard Industrial Code

**Accident Characteristics**

The elevation of the working level was recorded for 88% of the cases from information presented in the abstract. This field does not necessarily represent the elevation of the victim, but records the elevation of the working platform involved in the accident as referenced from ground level. For example, if an object was dropped from a scaffold level of 35 feet and the victim was struck at ground level, the elevation was recorded at 35 feet. A separate field was used to distinguish the victim in relation to the platform as either on, under, or above. Of all the cases with this information in the abstract, 95% were attributable to victims on the platform. However, being on the platform at a described

elevation does not necessarily mean that the victim fell, but 93.4% of the cases did involve falling from the elevation recorded. Therefore, when examining the elevation data any significance can be related to a victim falling from that elevation. Both fatality and injury-only cases were most common at heights of 11 to 20 feet, as shown in Figure 43. The median for all cases was at 22 feet, while the median for fatality cases was slightly higher at 27 feet and injury-only cases lower at 18 feet. The number of cases drops off very quickly after this peak of 11 to 20 feet. This indicates that the most common working heights in construction involving accidents are between 10 to 50 feet, as this accounts for 84% of the cases. It can be said that at the 11 to 20 feet level there is roughly a 50% chance that a fall incident will involve a fatality. Using this comparison at the other heights, it can be concluded that the likelihood of a fatality in an accident increases as the elevation of the platform increases, as shown in Figure 43.

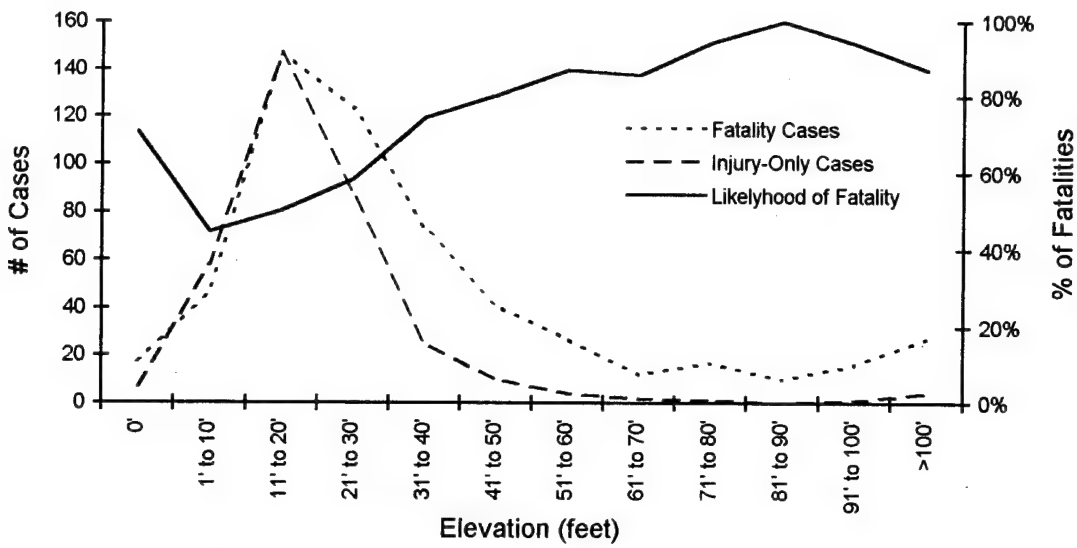


Figure 43: Cases by Platform Elevation and % of Fatalities

By comparing the elevation data to scaffold or opening cases an interesting similarity is revealed. While the number of cases differs for each, scaffold cases and opening cases both indicate the same predominance for accidents at 11 to 20 feet of elevation, as shown in Figure 44.

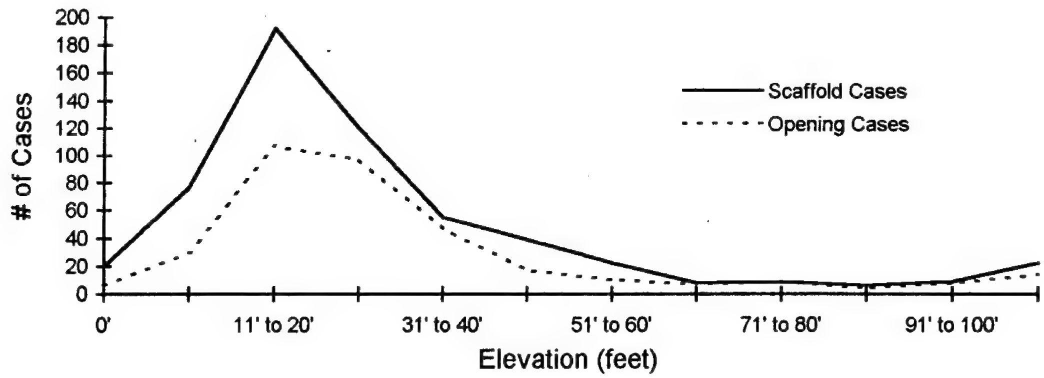


Figure 44: Scaffold and Opening Cases by Platform Elevation

**General Scaffold Accident Characteristics**

Of the 670 cases involving scaffolds, tubular welded frame scaffolds were involved most often, accounting for at least 17.1% of the scaffold fatality cases and 28.6% of the injury-only cases, as shown in Figure 45. Unfortunately, 15.5% of the scaffold cases did not contain sufficient information in the abstract to discern the type of scaffold involved. Therefore, it is likely that tubular welded frame scaffolds may have accounted for more. This does not necessarily indicate that tubular welded frame scaffolds are inherently more accident prone, rather it is likely one of the more popular types used at construction sites. When considering only fatalities, the manually-propelled mobile scaffolds and two-point suspension scaffolds are involved in nearly as many fatalities as tubular welded frame scaffolds. Again, this more likely indicates their popularity for use in construction, but may also indicate a vulnerability these scaffolds may have over stationary scaffolds. Each of the five most frequent scaffold types will be examined more closely in the following sections.

Each scaffold case was categorized by the type of accident and, not surprisingly, 90% of the scaffold cases were fall-related accidents. The type of fall was distinguished in two significant ways: fall from a scaffold and fall due to a collapsing scaffold. This distinction allows a more detailed examination of the causes related to each type. All other accident

descriptions were inconsequential compared to these two types of fall accidents, as shown in Figure 46. Interestingly, scaffold-related accidents involving electric shock accounted for 1% of scaffold injury-only cases and 9.6% of the scaffold fatality cases. The combination of electricity and scaffolds is not very forgiving as indicated by the higher percentage of fatalities.

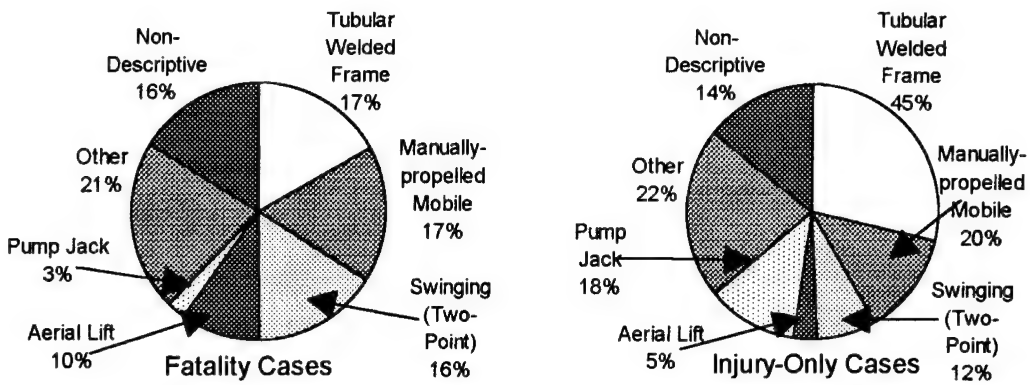


Figure 45: Cases by Scaffold Type (Top 5 Types)

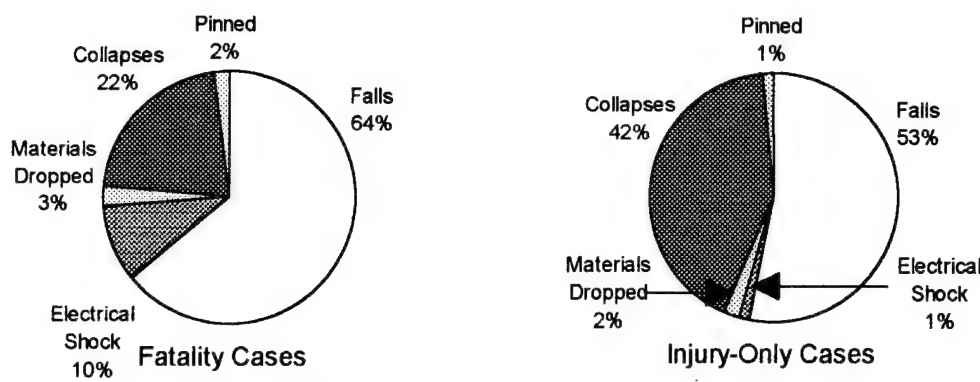


Figure 46: Scaffold Cases by Accident Description (Top 5 Types)

Each scaffold case was coded with two possible contributing causes based on the information provided in the case abstracts. While not required by 29 CFR 1926.451 for all scaffold types, the most common cause identified was the lack of a safety belt and lifeline, as shown in Figure 47. This cause was listed for any case where a lifeline might have prevented the fall from being severe, even though the type of scaffold may not have

required this protection by 29 CFR 1926.451. Only the two-point suspension, boatswain's chair, needle beam, float, and extensible/articulating boom aerial lift scaffold types specifically require lifelines to be used. The window and roof bracket scaffolds include lifelines as an option if guard rail protection is not provided. Five categories relate directly to the construction of the scaffold: structure broke, no guardrails, improper construction, planking unsecure/broke, and poor footing. Collectively these categories clearly indicate that the major cause contributing to scaffold accidents is the inability to construct a safe scaffold. When the type of accident is distinguished between falls, collapses, and other, the causes reflect expected results. Collapses tend to account for more accidents related to structural failure, improper construction (which often accompany structural failures), and tipping incidents. "Other" type accidents dominate the overhead danger category which is primarily due to electrical shock accidents when scaffolds contact power lines.

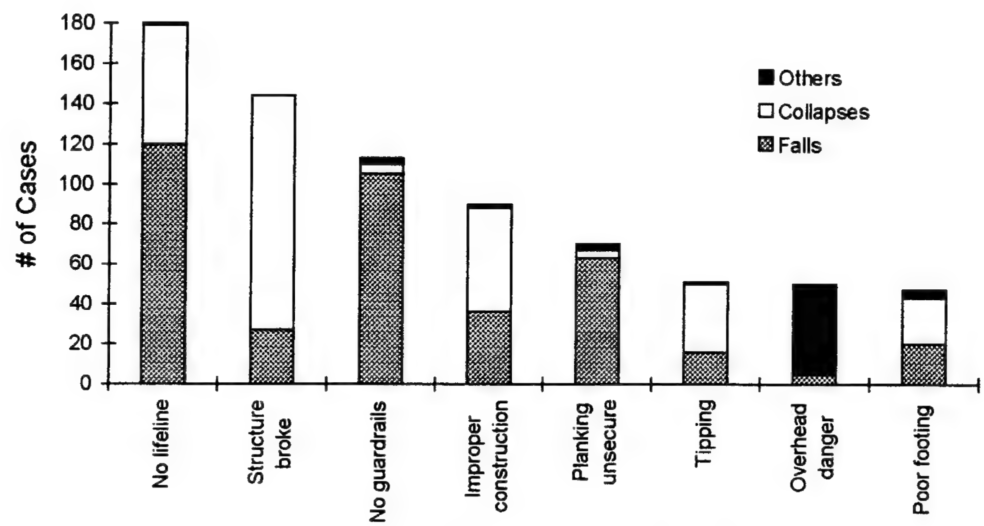


Figure 47: Scaffold Cases by Major Causes

Accident causes attributed to the working environment and human factors were assigned by the compliance officers for each case. Theses categories were less specific as the compliance officers attempted to attribute one environmental and human cause to each incident. The most common (52.8% of all scaffold cases and 52.5% of the scaffold

fatality cases) environmental cause cited as a problem was the working surface or facility layout condition (see Figure 48). Unfortunately, many specific environmental conditions could be described by this phase and no clear significance can be drawn from this category. This generality is followed by the second most frequently used code of "other" with 25.5% of all scaffold cases and 26.4% of the scaffold fatality cases.

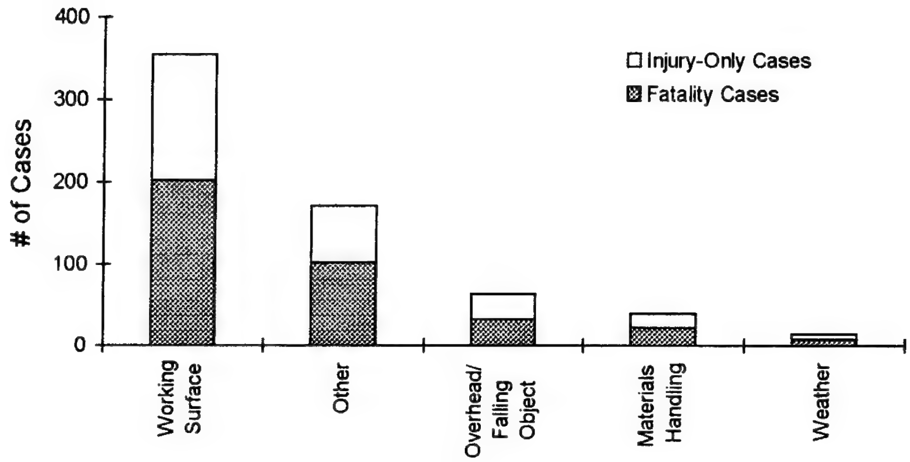


Figure 48: Scaffold Cases by Top 5 Environmental Causal Factors

This same lack of specificity is noticed in the human causal factors assigned by the compliance officers (see Figure 49). The most frequently attributed human cause is misjudgment of a hazardous condition which accounts for 34.2% of the scaffold cases and 34.6% of the scaffold fatality cases. Fortunately, some insight might be gathered from the next most common causes of "equipment in use was not appropriate for operation" (16.3% of scaffold cases) and "safety devices removed or inoperative" (15.7% of scaffold cases). These categories are sufficiently specific to give a clear indication of what was done wrong. The next category is an OSHA distinguished "other" classification which, unfortunately, was a frequently used category too general to interpret much information. The last category most frequently used was the lack of protective work clothing which normally includes personal protective equipment (PPE) such as eye protection, hearing protection, and work boots.

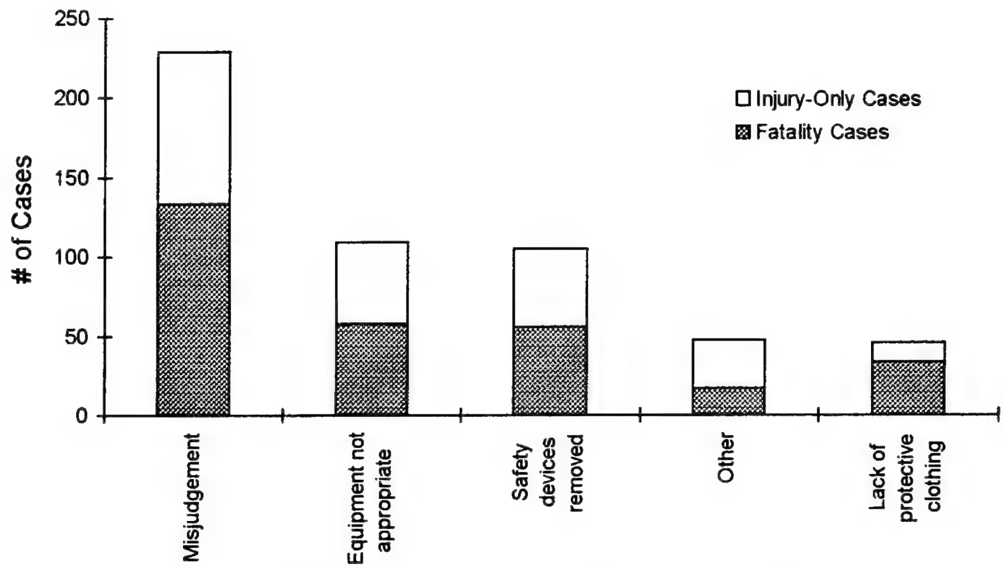


Figure 49: Scaffold Cases by Top 5 Human Causal Factors

Violations of the 29 CFR 1926 regulations were examined. Over 100 different CFR paragraphs were cited as violations for scaffold cases alone. The top 9 standards violated in scaffold accidents are shown in Table 3. The most commonly cited standard is 29 CFR 1926.021(b)(2) for the employer failing to properly instruct employees to recognize and avoid unsafe conditions. While this is a "catch-all" citation, probably used frequently for many types of cases, it does demonstrate a lack of employer interest towards rigorously implementing a safety program as noted in 30% of the scaffold accidents. Three other paragraphs from the general safety and health provisions subpart were listed in the top 9 citations. This indicates that the lack of employer interest in safety is a major contributing factor in accidents. The most common citation specific to scaffolds was 29 CFR 1926.451(a)(4) specifying the general requirement for guardrails and toeboards. Unfortunately, it is not precise as to whether the guardrails, toeboards, or both were the problem identified. Two other general scaffold citations occurred frequently for scaffold cases: paragraph 1926.451(a)(13) requiring safe access to the scaffold and paragraph 1926.451(a)(3) requiring supervision during the erection, movement, alteration or dismantling of scaffolds. The other citations dealing specifically with the individual scaffold types will be examined in the next section.

Table 3: Top Nine 29 CFR 1926 Citations for Scaffold Cases
(excludes scaffold specific citations)

| 29 CFR 1926 | Description | # of Fatality Cases (%)* | # of Injury-Only Cases (%)** |
|---|---|---|---|
| 021(b)(2) | Instruction of employees to recognize and avoid unsafe conditions. | 123 (31.8%) | 80 (28.3%) |
| 451(a)(4) | General requirement for guardrails and toeboards. | 57 (14.7%) | 47 (16.6%) |
| 059(e)(1) | Employers shall maintain a written Hazard Communication Program. | 44 (11.4%) | 23 (8.1%) |
| 020(b)(1) | Employer to initiate and maintain safety programs. | 40 (10.3%) | 36 (12.7%) |
| 028(a) | Employer shall enforce wearing PPE as appropriate. | 36 (9.3%) | 18 (6.4%) |
| 059(h) | Employers shall provide information and training on hazardous chemicals used. | 36 (9.3%) | 16 (5.7%) |
| 451(a)(13) | Requires means of safe access to the scaffold. | 30 (7.8%) | 46 (16.3%) |
| 020(b)(2) | Programs to include regular inspections of work sites by competent personnel. | 28 (7.2%) | 27 (9.5%) |
| 451(a)(3) | Requires supervision during the erection, movement, alteration or dismantling of scaffolds. | 28 (7.2%) | 23 (8.1%) |

* Percentages reflect the percent of 387 scaffold fatality cases.

** Percentages reflect the percent of 283 scaffold injury-only cases.

The nature of the use of scaffolding at the time of accident occurrence was interpreted from the descriptions in the abstract. For nearly 78% of the scaffold cases, the scaffold was being "used" for its intended purpose, as shown in Figure 50. Accidents involving erecting, dismantling, and moving the scaffold after it was erected, which might be thought of as the most dangerous periods for a scaffold, were not as frequent, but still accounted for 17% of the scaffold-related accidents.

The mean platform elevations of the 5 most frequently-involved scaffold types were compared, as shown in Figure 51. This showed what could be considered as typical

working heights for these types of scaffolds. Swinging scaffolds, supported from the roof, would be expected to have the highest mean elevation. Mobile scaffolds (manually propelled) would, understandably, have the shortest operating height due to its inherent instability. As previously noticed between elevation and fatalities in general, the mean operating height might be expected to increase slightly for fatal cases, as indicated in Figure 51. The pump jack scaffold, however, seems to defy this notion with a lower mean working elevation for fatal cases. The significance of this may not be important as only 10 fatality cases involved pump jack scaffolds.

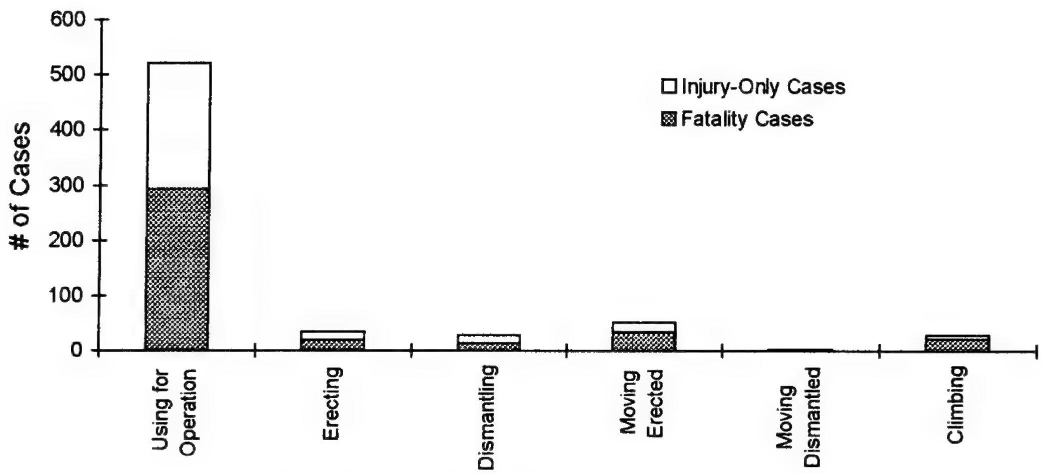


Figure 50: Scaffold Cases by Scaffolding Use

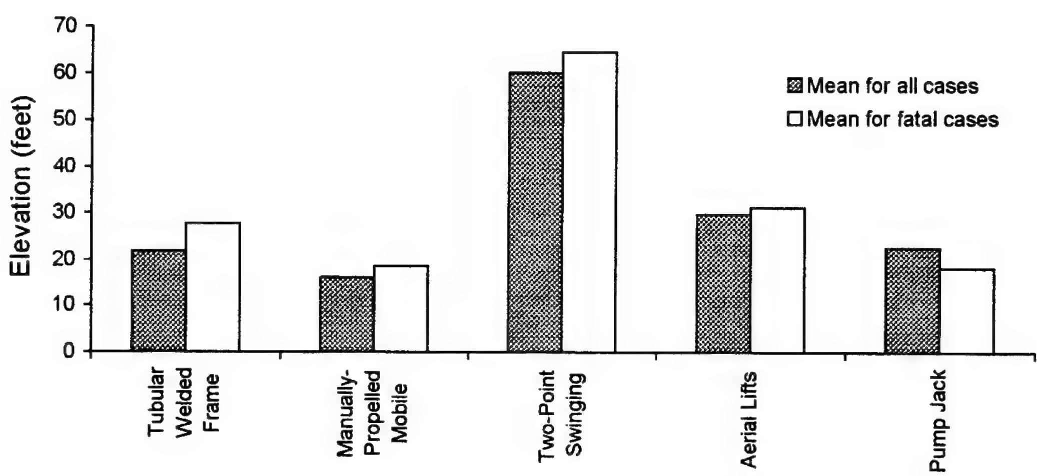


Figure 51: Mean Elevation by Scaffold Type

**Tubular Welded Frame Scaffolds**

As mentioned earlier, the tubular welded frame scaffold seems to be the most popular scaffold type used in construction involved in 147 cases of which 66 cases involved fatalities. The most popular operation, by all indications of the accident data, is masonry work accounting for 41.5% of all recorded uses of this scaffold type (see Figure 52). The next most frequent operation was painting, at 6.8% of the cases for this scaffold.

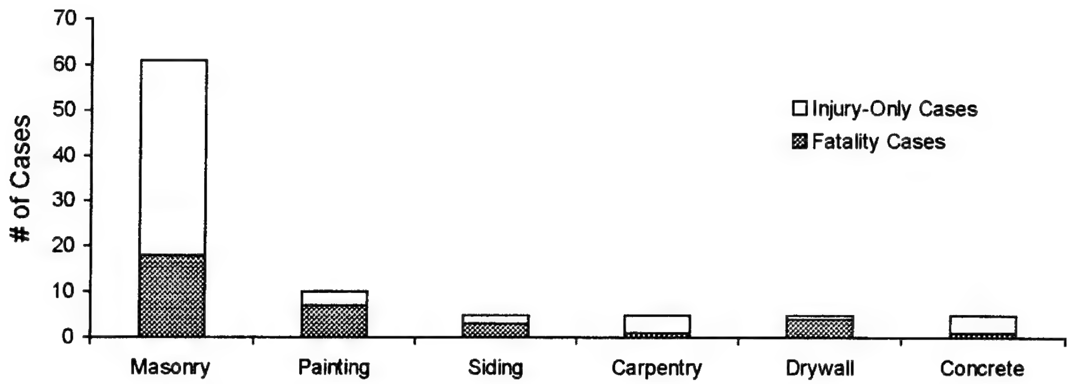


Figure 52: Tubular Welded Frame Scaffold Cases by Type Work Performed

Falls from and collapses of this scaffold accounted for 89.8% of all cases and 86.4% of all fatality cases involving this type (see Figure 53). Interestingly, only 13.6% of the fatality cases were classified as collapses. In many cases the abstract described collapses where the workers on the scaffold "rode the scaffold down" which likely slowed the rate of decent and prevented some fatalities.

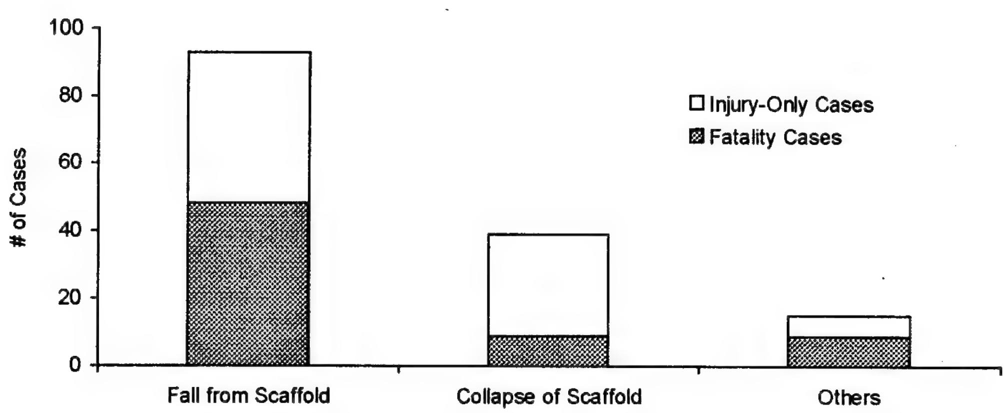


Figure 53: Tubular Welded Frame Scaffold Cases by Accident Type

The major causes attributed to tubular welded frame scaffolds focused on the construction of the scaffold (see Figure 54). The 5 most frequent causes involving the construction of the tubular welded frame scaffold accounted for 57% of all cases for this scaffold type. The most surprising fact is that 15.6% of the fatalities are due to not having guardrails installed as required. No complex engineering solution is required to remedy this portion of this scaffold's problem. The equipment simply needs to be utilized as it was designed. Work environment and human causal factors for this scaffold type did not vary from the relative frequencies noticed for all scaffold types reflected in Figures 48 and 49.

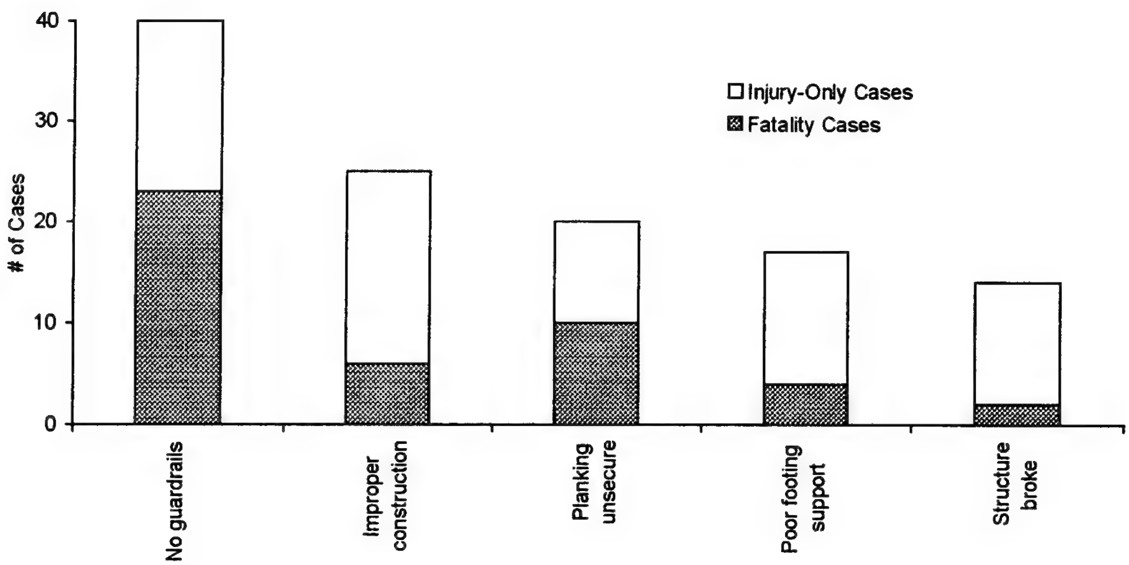


Figure 54: Tubular Welded Frame Scaffold Cases by Top 5 Accident Causes

The most common 29 CFR 1926.451 citation given for accidents involving tubular welded frame scaffolds is 451(d)(10) specifying the guardrail requirements which accounted for 61.2% of all cases involving this scaffold type (see Table 4). The 6 most frequently-cited citations closely match the recorded causes.

Table 4: Top Six 29 CFR 1926 Citations for
Tubular Welded Frame Scaffold Cases

| 29 CFR 1926 | Description | # of Fatality Cases (%)* | # of Injury-Only Cases (%)** |
|---|---|---|---|
| 451(d)(10) | Specifies the guardrail requirements. | 38 (57.6%) | 52 (64.2%) |
| 451(a)(13) | Requires access ladders to scaffolds. | 16 (24.2%) | 31 (38.3%) |
| 451(d)(3) | Specifies tubular welded frame bracing. | 16 (24.2%) | 21 (25.9%) |
| 451(d)(7) | Specifies securing the scaffold to buildings at designated intervals. | 8 (12.1%) | 13 (16.0%) |
| 451(d)(4) | Specifies proper footing of the tubular welded frame scaffold. | 5 (7.6%) | 15 (18.5%) |
| 451(a)(14) | Specifies scaffold planking placement. | 4 (6.1%) | 17 (20.0%) |

* Percentages reflect the percent of 66 tubular welded frame scaffold fatality cases.
** Percentages reflect the percent of 81 tubular welded frame scaffold injury-only cases.

**Manually-Propelled Mobile Scaffolds**

Manually-propelled mobile scaffolds were the second most frequent type of scaffold involved with the scaffold accidents involved in 102 cases, but actually accounted for more fatalities (69 fatalities in 65 cases) than the tubular welded frame scaffolds (68 fatalities). As indicated earlier, the large ratio of fatalities to injuries associated with this type scaffold may be related to its inherent instability and improper technique to move them. While most accidents still occur during regular use, at 61.8%, a large amount are associated with moving the scaffold, at 27.5% (see Figure 55). This increase in accidents for this category is apparently due to the instability of a scaffold that is mobile.

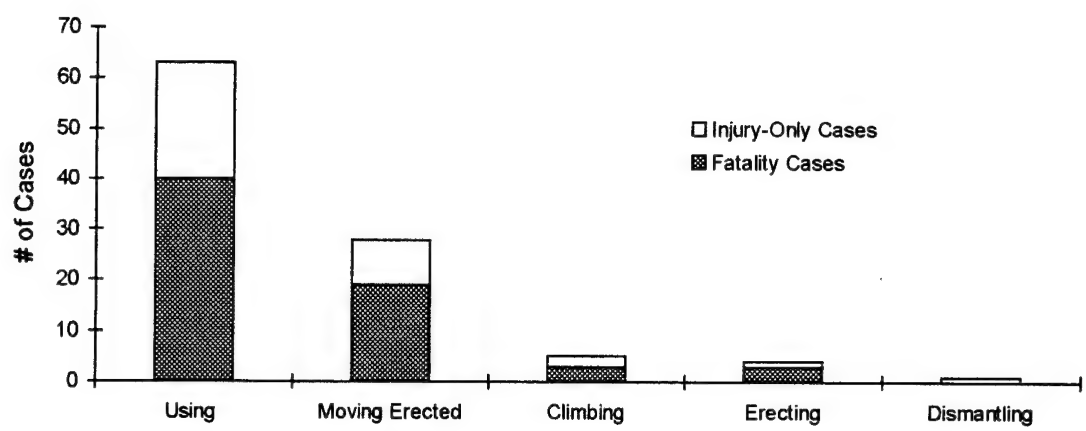


Figure 55: Manually-Propelled Mobile Scaffold Cases by Scaffolding Use

The most common operation performed with the manually-propelled mobile scaffold was drywall and ceiling work, accounting for 24.5% of the cases followed closely by painting at 18.6% (see Figure 56). This usage is typical as the mobility of mobile scaffolds is convenient during interior drywall operations. Painting operations are also accommodated by mobile scaffolds.

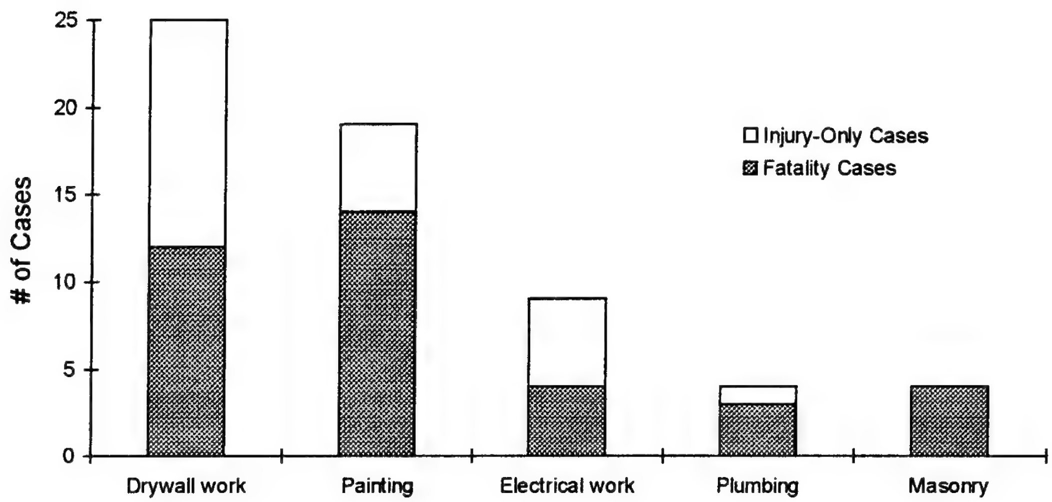


Figure 56: Manually-Propelled Scaffold Cases by Type Work Performed

Accidents involving manually-propelled scaffolds, as with most scaffold accidents, were most commonly described as falls from the scaffold platform at 61.8% and accounted for 52.3% of the fatalities (see Figure 57). Collapses were the second most common, at 15.7%, followed closely by electrical shock at 14.7%. Collapses for this scaffold type included situations when the scaffold tipped over. The tipping action was typically caused by the scaffold hitting an irregularity on the floor or caused by the worker improperly moving the scaffold by pushing on a nearby wall or ceiling. The high number of cases related to electrical shocks is mostly related to situations where the scaffold hits an overhead powerline during movement. Not surprisingly, fatalities accounted for 93.3% of the electrical shock cases.

The lack of guardrails was recorded as the most common cause of manually-propelled mobile scaffold accidents accounting for 25.5% of the mobile scaffold cases and 12.7% of

the fatality cases (see Figure 58). This was followed closely by an action which caused the scaffold to tip over (23.5%). The third cause, associated with electrical shock, was inattention to overhead obstacles at 13.7% of the cases. Electrical shock accounted for fatalities in 92.8% of the cases related to this cause. Work environment and human causal factors for this scaffold type did not vary from the relative frequencies noticed for all scaffold types reflected in Figures 48 and 49.

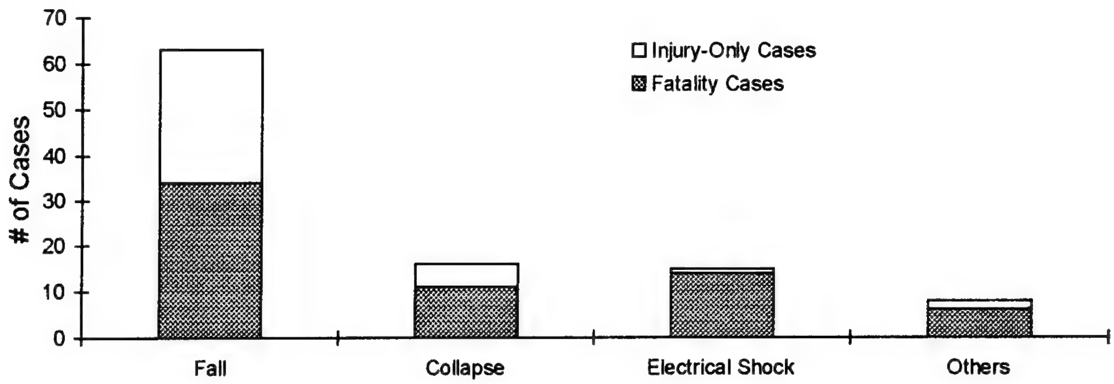


Figure 57: Manually-Propelled Mobile Scaffold Cases by Accident Type

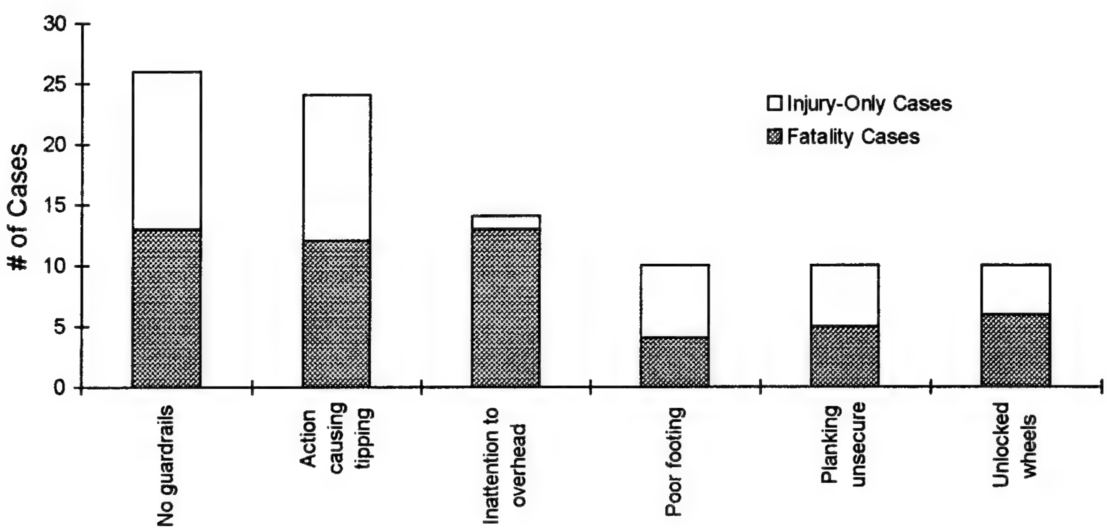


Figure 58: Manually-Propelled Mobile Scaffold Cases by Top 6 Accident Causes

Citations assigned for this scaffold type were reflective of the causes as the most frequently cited standard in the 29 CFR 1926 regulations was the specification for proper

guardrails (see Table 5). Both paragraphs 451(e)(10), covering the specific requirements for manually-propelled mobile scaffold guardrails, and 451(a)(4), covering the general requirements for scaffold guardrails were cited for failure to provide this important protection. The next most frequently cited standard was 451(e)(4) requiring tight and secure planking (33.3% of cases). While this citation does not match the ranking of the causes it is not unusual for the planking to be unsatisfactory for accidents attributed to tipping or overhead obstructions.

Table 5: Top Five 29 CFR 1926 Citations for Manually-Propelled Mobile Scaffold Cases

| 29 CFR 1926 | Description | # of Fatality Cases (%)* | # of Injury-Only Cases (%)** |
|---|---|---|---|
| 451(e)(10) | Specific requirement for guardrails on the manually-propelled mobile scaffold. | 41 (63.1%) | 12 (32.4%) |
| 451(e)(4) | Requirement for tight and secure planking. | 20 (30.8%) | 14 (37.8%) |
| 451(e)(8) | Requirement for proper footing support and locked wheels. | 14 (21.5%) | 9 (24.3%) |
| 451(a)(4) | General requirement for proper guardrails. | 11 (16.9%) | 6 (16.2%) |
| 451(e)(3) | Requirement for proper bracing. | 10 (15.4%) | 9 (24.3%) |

* Percentages reflect the percent of 65 manually-propelled mobile scaffold fatality cases.
** Percentages reflect the percent of 37 manually-propelled mobile scaffold injury-only cases.

**Swinging (Two-Point Suspension) Scaffolds**

The third most frequently recorded type of scaffold is the swinging or two-point suspension scaffold. This type of scaffold typically operates at a higher elevation than the other scaffold types , as shown in Figure 51. With a mean elevation of 60 feet for all cases and 64.4 feet for fatality cases it is not surprising that fatalities account for 74.4% of all cases involving this scaffold type. As might be expected, 88.5% of the accidents associated with this type occur during regular use since erecting and dismantling of this scaffold occurs mainly at the ground level (see Figure 59).

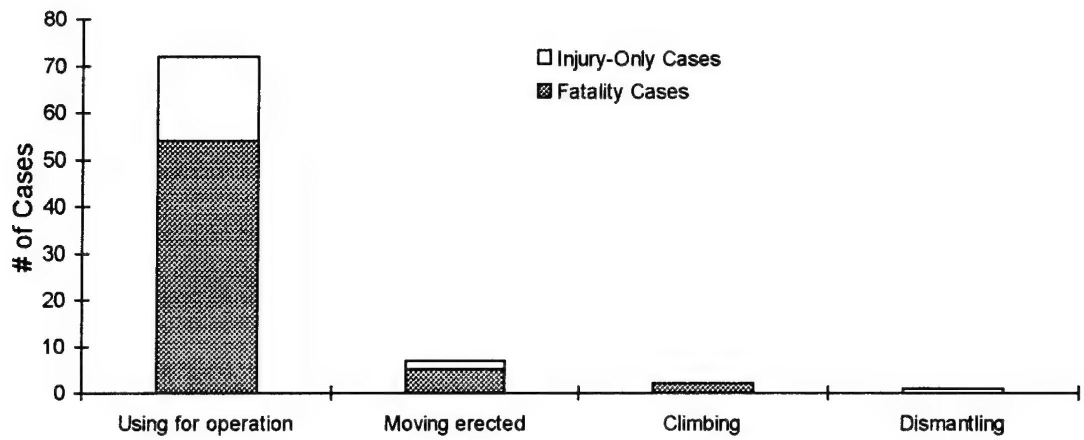


Figure 59: Swinging Scaffold Cases by Scaffolding Use

Painting seems to dominate the use of two-point swinging scaffolds, accounting for 40.2% of all case operations of this scaffold type (see Figure 60). Unfortunately, 39% of the cases were not able to be classified given the information provided by the abstracts. Various other operations were mostly building exterior operations which included siding and glazing operations.

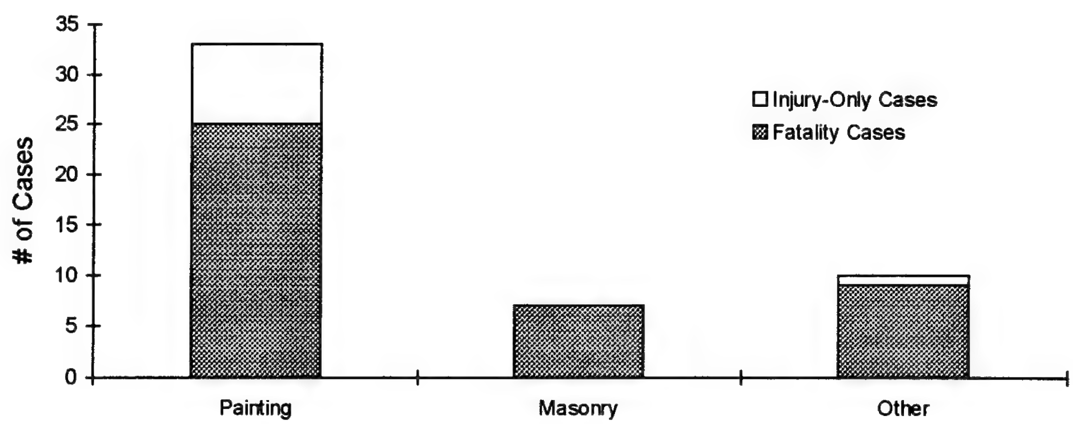


Figure 60: Swinging Scaffold Cases by Type Work Performed

The type of accident consisted of mainly two types (see Figure 61). Falls from the swinging scaffold platform accounted for 47.6% of the cases and 47.5% of the fatalities. Collapses of the scaffold accounted for 45.1% of the cases and 49.2% of the fatalities.

Collapses mostly consisted of one or both of the lines breaking and, as described in the next paragraph, workers were not wearing lifelines. On a positive note, there were four cases recorded where lifelines were used and, as designed, fatalities were prevented.

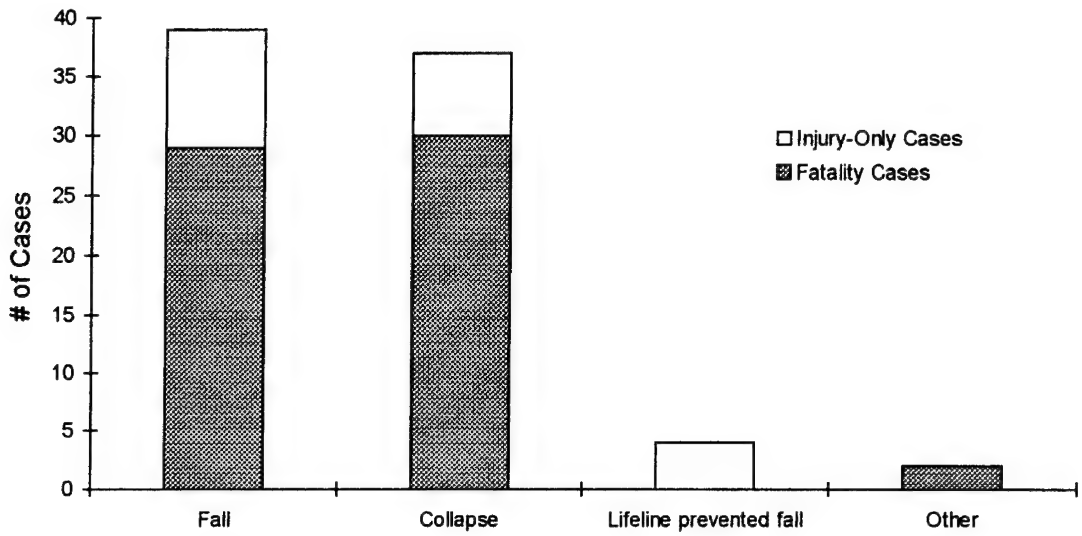


Figure 61: Swinging Scaffold Cases by Accident Type

A lack of a lifeline or safety net was the most frequently recorded cause for the swinging scaffold accidents accounting for 57.3% of the cases and 60.7% of the fatalities involving this scaffold type (see Figure 62). While the lack of guardrails was not as common with 4.8% of the cases, guardrails could not stop workers from falling when the next major cause was the scaffold structure breaking. Accounting for 47.6% of the cases and 47.5% of the fatalities, the collapse of the scaffold by breaking is significant. Lifelines were the only viable means by which these fatalities could have been prevented. Work environment causal factors for this scaffold type did not vary from the relative frequencies noticed for all scaffold types reflected in Figure 48. The human causal factors did cite the category "safety devices removed or inoperative" most frequently for these scaffold accidents.

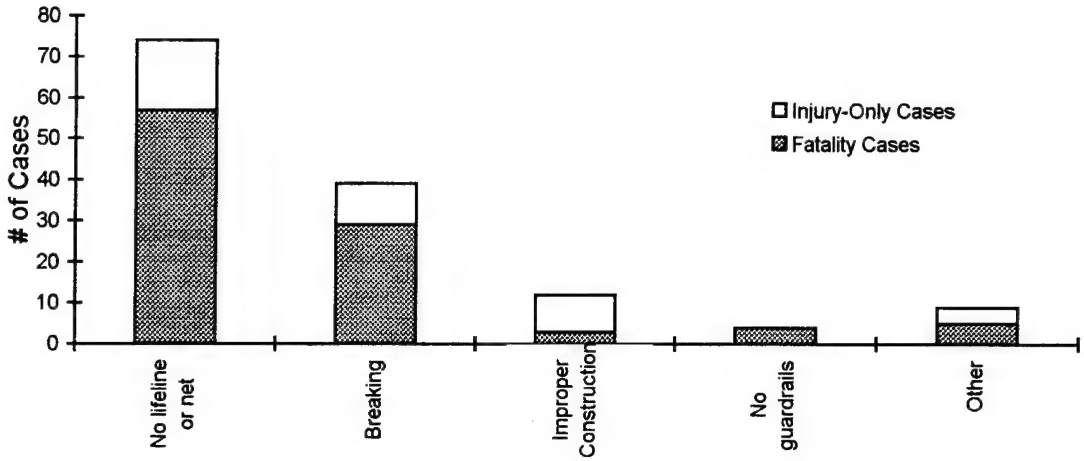


Figure 62: Swinging Scaffold Cases by Accident Causes

The 29 CFR 1926 citations assigned reflected the lack of lifelines and other major causes recorded (see Table 6). Besides requiring lifelines during the operation of the swinging scaffold, paragraph 451(i)(8) specifies the limits for live loading to be placed on the scaffold. Considering the structural paragraphs 451(i)(4) and (7) collectively, the number of cases closely matches those categorized previously as breaking.

Table 6: Top Six 29 CFR 1926 Citations for Swinging (Two-Point Suspension) Scaffold Cases

| 29 CFR 1926 | Description | # of Fatality Cases (%)* | # of Injury-Only Cases (%)** |
|---|---|---|---|
| 451(i)(8) | Specifies the live load limits and requirements for lifelines. | 43 (70.5%) | 13 (61.9%) |
| 451(i)(4) | Specifies the requirements for roof tiebacks and hooks. | 24 (39.3%) | 6 (28.6%) |
| 451(i)(11) | Specifies guardrail requirements. | 23 (37.7%) | 7 (33.3%) |
| 451(a)(3) | Requirement for supervision when erecting, moving, or dismantling scaffolds. | 11 (18.0%) | 2 (9.5%) |
| 451(i)(9) | Specifies the lashing requirements to prevent swaying. | 11 (18.0%) | 2 (9.5%) |
| 451(i)(7) | Requires all suspension ropes to be inspected. | 8 (13.1%) | 1 (4.8%) |

* Percentages reflect the percent of 61 swinging (two-point suspension) scaffold fatality cases.

** Percentages reflect the percent of 21 swinging (two-point suspension) scaffold injury-only cases.

**Extensible and Articulating Boom Aerial Lifts**

Aerial lifts, particularly the extensible and articulating boom types of lifts, were the fourth most common type of scaffold involved in accidents, with 48 cases. As seen in Figure 45 earlier, this type of powered scaffold had the largest percentage of fatalities at 77.1% of the cases. Again, like the manually-propelled mobile scaffolds, the instability of this scaffold may be the reason for this high fatality rate. As seen in Figure 63, moving of the erected aerial lifts accounted for only 4.2% of the cases while all other cases occurred during regular use. Movement in this case is defined as horizontal motion of the equipment rather than vertical motion of the basket.

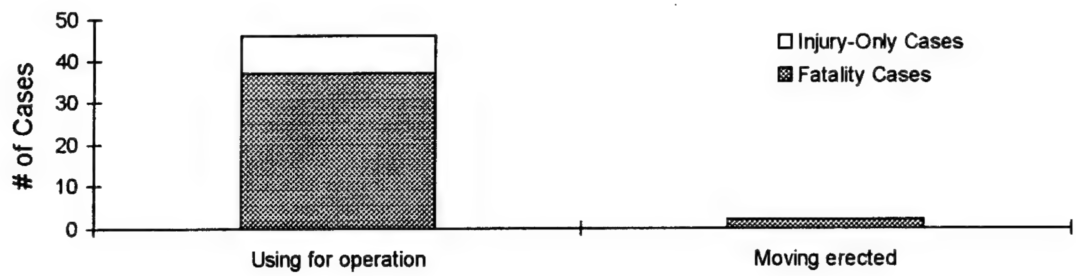


Figure 63: Extensible and Articulating Boom Aerial Lift Cases by Scaffolding Use

While the type of construction operation using aerial lifts varied greatly, the most frequently-cited operation was electrical work accounting for 43.8% of the cases and 46.2% of the fatality cases (see Figure 64). Unfortunately, 25% of the cases could not be attributed to a construction operation due to the limited information provided in the abstract.

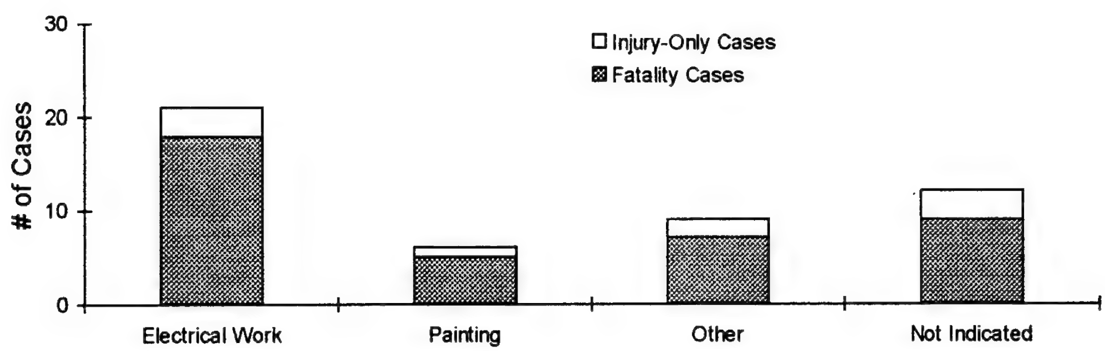


Figure 64: Extensible and Articulating Boom Aerial Lift Cases by Type Work Performed

The type of accident occurring most frequently with aerial lifts was, as with other scaffolds, falls from the working platform (see Figure 65). While falls accounted for 43.8% of the cases, 90.5% of the falls resulted in fatalities which is the highest fatality rate of any of the scaffolds examined. The next two types of accidents most frequently occurring simulate the relative results seen with manually-propelled mobile scaffolds in Figure 55. Electrical shock which accounted for 25% of the cases were all fatality cases. Collapse cases, accounting for 22.9% of the cases, were only 45.5% fatalities. Collapses, as with manually-propelled mobile scaffolds, involved tipping over as well as structural failures.

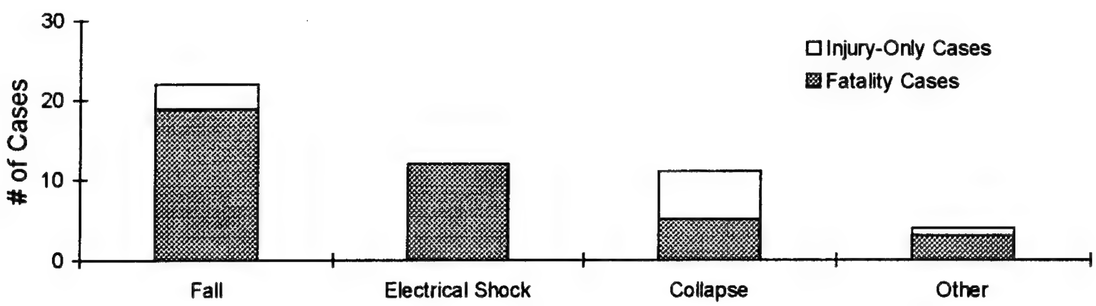


Figure 65: Extensible and Articulating Boom Aerial Lift Cases by Accident Type

The major cause of accident identified was the inattention to overhead obstructions accounting for 33.3% of the cases of which all were fatalities (see Figure 66). Commonly, the collision with an overhead obstruction lead to electrical shocks and or being knocked out of the basket platform. Thus, it is logical to expect the next major cause to be a lack of lifeline support which accounted for 27% of the cases with 92.3% being fatalities. Poor footing, structure breaking, and tipping action all contributed to the collapse type accidents and collectively accounted for 45.8% of the cases. Work environment causal factors for aerial lifts did not vary from the relative ranking of other scaffolds, as previously shown in Figure 48, except for a higher number of cases categorized as "other." Human causal factors varied slightly from the relative rankings shown in Figure 49 with "the lack of protective work clothing" being the second most cited factor.

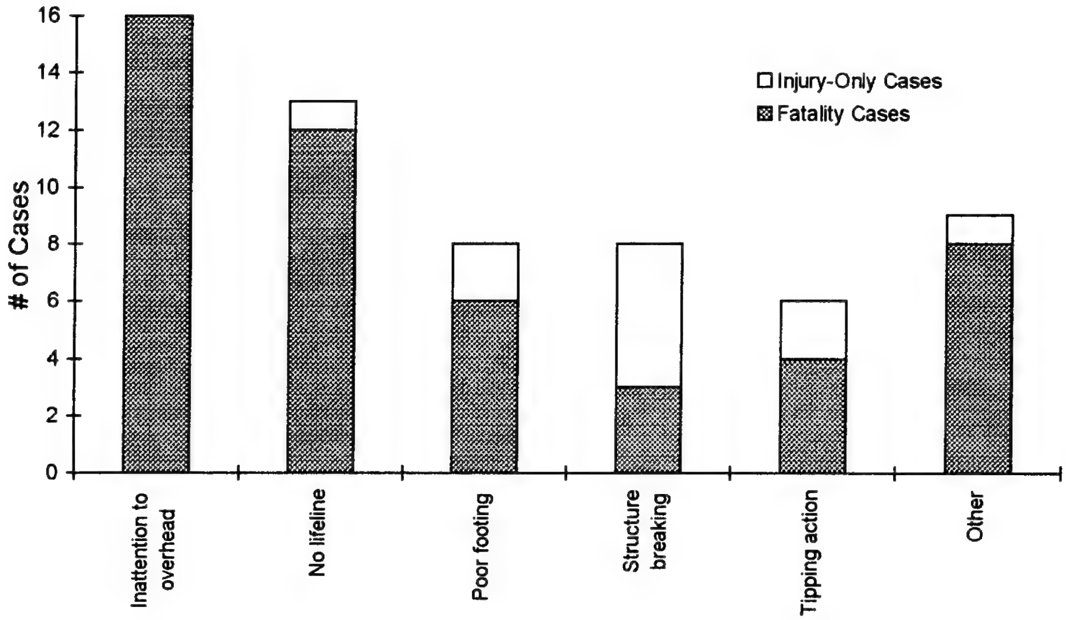


Figure 66: Extensible and Articulating Boom Aerial Lift Cases by Causes

Only one significant 29 CFR 1926 paragraph standard was cited most frequently. Paragraph 556(b)(2) which specified nearly all requirements for the extensible and articulating boom aerial lifts accounted for 68.7% of the cases and 69.2% of the fatalities. Unfortunately, individual standards within this paragraph were not recorded.

**Pump Jack Scaffolds**

Pump jack scaffolds are one of the more unusual scaffold types and because of its convenient vertical adjustment mechanism it seems to be a very popular scaffold system in construction. Like most other scaffolding accidents, occurrances were more frequent during regular use (90.7%) than by erecting or dismantling (see Figure 67). The use is predominantly in the residential construction industry. Of the 43 cases involving pump jack scaffolds 46.5% specifically indicated their use for residential construction while the remainder failed to indicate any particular segment of the industry. The construction operation responsible for this seems to be siding installation accounting for 51.2% of the cases, as shown in Figure 68. With 27.9% of the cases not indicating a construction operation, it is possible that usage of pump jacks in residential siding installation is larger.

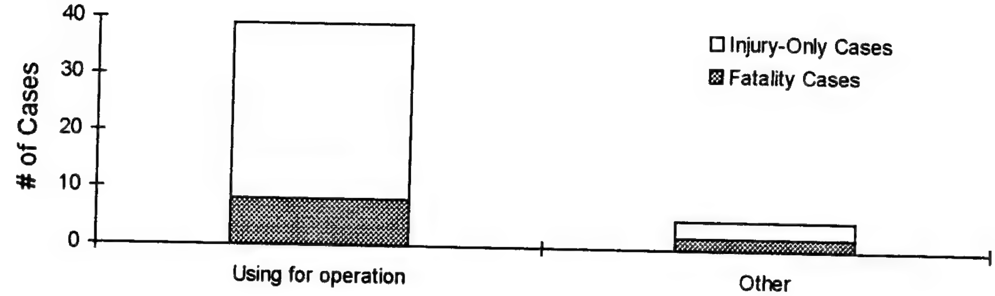


Figure 67: Pump Jack Scaffold Cases by Scaffolding Use

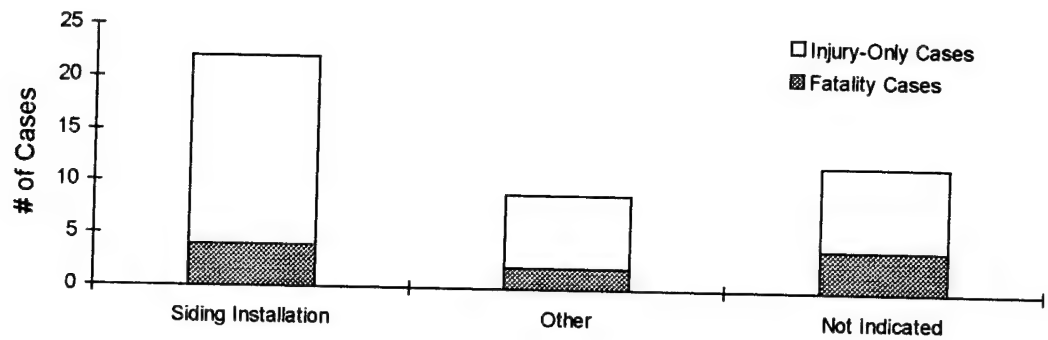


Figure 68: Pump Jack Scaffold Cases by Type Work Performed

With only 23.3% of the cases involving a fatality, pump jack scaffolds seem to be one of the safer scaffolds in use. This record could be improved by realizing that collapses are the major reason for accidents, accounting for 72.1% of all the cases (see Figure 69). Since both collapses and falls involve a worker falling from an elevation, the combined number of fatalities from these categories account for 90% of the fatality cases.

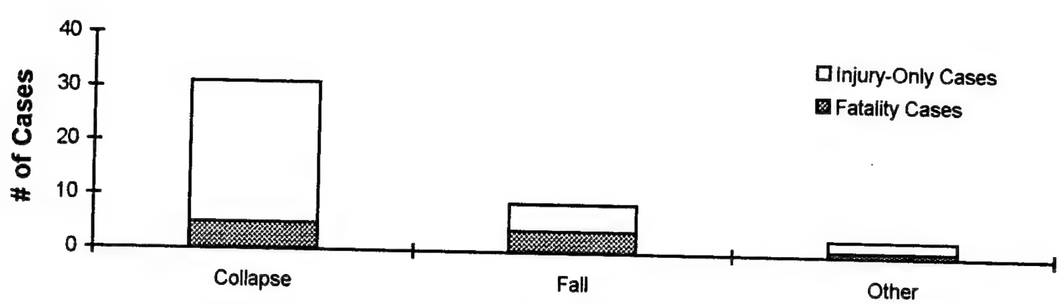


Figure 69: Pump Jack Scaffold Cases by Accident Type

The main cause for these collapses is a structural failure which is attributed to 62.8% of the cases (see Figure 70). The structure most responsible is the 2x4 lumber pole on which the pump jack scaffold is based. A related, but more generic cause, is improper construction, accounting for 32.6% of the cases, which typically leads to a structural failure. Again, as seen with other scaffold types, the lack of guardrails or lifeline accounted for 25.6% of the cases. Overloading the scaffold was another major contributor leading to structural failure. This category, which includes overloading by either workers or materials, accounts for 20.9% of the cases involving this scaffold type. Work environment and human causal factors for this scaffold type did not vary from the relative frequencies noticed for all scaffold types reflected in Figures 48 and 49.

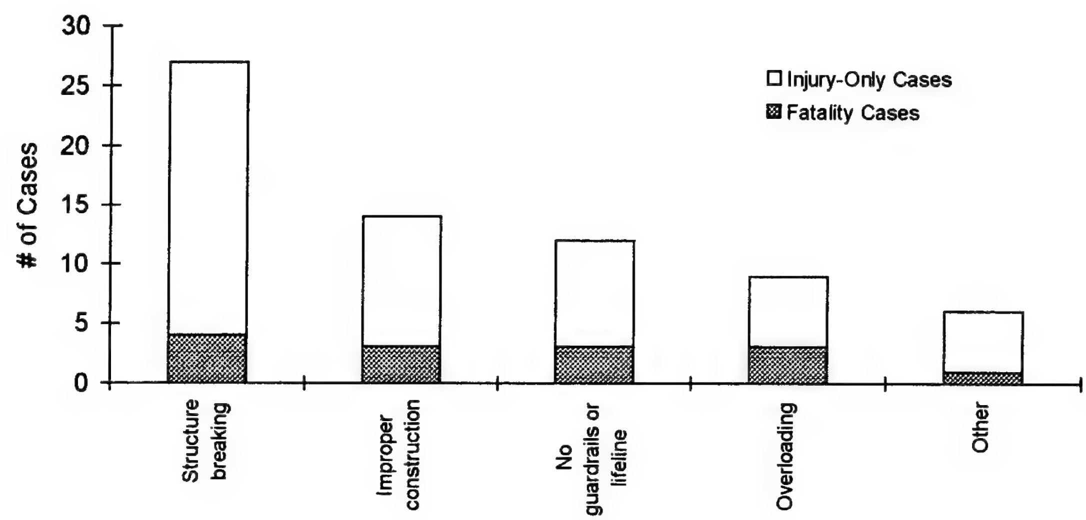


Figure 70: Pump Jack Scaffold Cases by Causes

As expected, the most frequently cited 29 CFR 1926 standard was paragraph 451(y)(4) specifying the pole placement, height limits and bracing requirements cited in 67.4% of the cases (see Table 7). The second most cited standard was 451(y)(11) accounting for 46.5% of the cases which describes the guardrail or lifeline requirements that could have prevented the injuries and fatalities associated with this scaffold. The need for guardrails was also cited under 451(a)(4) accounting for 25.6% of the cases.

Table 7: Top Six 29 CFR 1926 Citations for
Pump Jack Scaffold Cases

| 29 CFR 1926 | Description | # of Fatality Cases (%)* | # of Injury-Only Cases (%)** |
|---|---|---|---|
| 451(y)(11) | Specifies the guardrail or lifeline requirements for the pump jack scaffold. | 5 (50.0%) | 15 (45.5%) |
| 451(y)(4) | Specifies the pole placement, height limits and bracing requirements. | 4 (40.0%) | 25 (75.8%) |
| 451(y)(1) | Specifies the load limits on the pump jack scaffold. | 3 (30.0%) | 8 (24.2%) |
| 451(y)(3) | Requires secure and tight planking. | 3 (30.0%) | 7 (21.2%) |
| 451(y)(6) | Specifies the type of lumber which should be used as the pole. | 3 (30.0%) | 7 (21.2%) |
| 451(a)(4) | General requirement for guardrails on scaffolds. | 1 (10.0%) | 10 (30.3%) |

* Percentages reflect the percent of 10 pump jack scaffold fatality cases.
** Percentages reflect the percent of 33 pump jack scaffold injury-only cases.

**Scaffold Summary**

Comparing the accident characteristics with the 5 scaffold types most frequently involved in scaffold accidents, some interesting distinctions can be made between the scaffold types (see Table 8). Scaffold-related accidents occurred primarily when the scaffold was used for its intended purpose. The only scaffold type which had a significant amount of accidents outside of its intended use was the manually-propelled mobile scaffold. Likewise, falls from and collapses of the scaffold was the most common type of accident. The other significant accident type was electrical shock which primarily occurred with manually-propelled mobile scaffolds and extensible/articulating boom aerial lifts. Note that the accident characteristics have been tabulated for all major scaffold types. Since those not shown in Table 8 were associated with only a few accidents, no conclusions can be drawn (see Table 9). No accidents involving plaster's, decorator's, and large area scaffolds; window jack scaffolds; or stone setter's adjustable multi-point suspension scaffolds were recorded.

Table 8: Comparison of Top 5 Scaffold Types

| Scaffold Type / Accident Characteristics | Tubular Welded Frame Scaffold | Manually-Propelled Mobile Scaffold | Two-Point Suspension Scaffold | Extensible/ Articulating Boom Aerial Lift | Pump Jack Scaffold |
|---|---|---|---|---|---|
| Scaffold Use | | | | | |
| Using | 109 (74.1%) | 63 (61.8%) | 72 (87.8%) | 46 (95.8%) | 39 (90.7%) |
| Moving Erected | 2 (1.4%) | 28 (27.5%) | 7 (8.5%) | 2 (4.2%) | 0 |
| Climbing | 11 (7.5%) | 5 (4.9%) | 2 (2.4%) | 0 | 1 (2.3%) |
| Erecting | 14 (9.5%) | 4 (3.9%) | 0 | 0 | 2 (4.7%) |
| Dismantling | 11 (7.5%) | 1 (1.0%) | 1 (1.2%) | 0 | 1 (2.3%) |
| Not Indicated | 0 | 1 (1.0%) | 0 | 0 | 0 |
| | 147 (100%) | 102 (100%) | 82 (100%) | 48 (100%) | 43 (100%) |
| | | | | | |
| Accident Type | | | | | |
| Fall | 95 (64.6%) | 68 (66.7%) | 39 (47.6%) | 21 (43.8%) | 10 (23.3%) |
| Collapse | 39 (26.5%) | 16 (15.7%) | 37 (45.1%) | 11 (22.9%) | 31 (72.1%) |
| Elec. Shock | 0 | 15 (14.7%) | 0 | 12 (25.0%) | 2 (4.7%) |
| Other | 13 (8.8%) | 3 (2.9%) | 6 (7.3%) | 4 (8.3%) | 0 |
| | 147 (100%) | 102 (100%) | 82 (100%) | 48 (100%) | 43 (100%) |
| | | | | | |
| Type Work Performed | | | | | |
| Masonry | 61 (41.5%) | 4 (3.9%) | 7 (8.5%) | 1 (2.1%) | 0 |
| Painting | 10 (6.8%) | 19 (18.6%) | 33 (40.2%) | 6 (12.5%) | 2 (4.7%) |
| Siding | 5 (3.4%) | 2 (2.0%) | 2 (2.4%) | 1 (2.1%) | 22 (51.2%) |
| Drywall | 5 (3.4%) | 25 (24.5%) | 0 | 0 | 0 |
| Elec. Work | 0 | 9 (8.8%) | 0 | 21 (43.8%) | 0 |
| Other | 21 (14.3%) | 18 (17.6%) | 8 (9.8%) | 7 (14.6%) | 7 (16.3%) |
| Not Indicated | 45 (30.6%) | 25 (24.5%) | 32 (39.0%) | 12 (25.0%) | 12 (27.9%) |
| | 147 (100%) | 102 (100%) | 82 (100%) | 48 (100%) | 43 (100%) |
| | | | | | |
| Causes* | | | | | |
| No guardrails | 40 (27.2%) | 26 (25.5%) | 5 (6.1%) | 0 | 6 (14.0%) |
| Improper construction | 25 (17.0%) | 8 (7.8%) | 12 (14.6%) | 1 (2.1%) | 14 (32.6%) |
| Unsecure planking | 20 (13.6%) | 10 (9.8%) | 0 | 0 | 2 (4.7%) |
| Poor footing | 17 (11.6%) | 10 (9.8%) | 0 | 8 (16.7%) | 0 |
| Structure breaking | 14 (9.5%) | 1 (1.0%) | 39 (47.6%) | 8 (16.7%) | 27 (62.8%) |
| Tipping | 10 (6.8%) | 24 (23.5%) | 1 (1.2%) | 6 (12.5%) | 0 |
| Overhead obstruction | 11 (7.5%) | 14 (13.7%) | 0 | 16 (33.3%) | 2 (4.7%) |
| No lifeline | 9 (6.1%) | 5 (4.9%) | 74 (90.2%) | 13 (27.1%) | 5 (11.6%) |
| Other | 44 (29.9%) | 29 (28.4%) | 7 (8.5%) | 9 (18.8%) | 10 (23.3%) |
| | | | | | |

* Percentages for causes will not necessarily add to 100% since two causes are assigned to each case.

Table 9: Comparison of Remaining Scaffold Types

| Scaffold Type / Accident Characteristics | Aerial Lifts (Scissor-Type) | Carpenter's Bracket | Ladder Jack | Makeshift* | Roofing Brackets |
|---|---|---|---|---|---|
| Scaffold Use | | | | | |
| Using | 17 (65.4%) | 15 (100%) | 11 (84.6%) | 12 (92.3%) | 9 (90%) |
| Moving Erected | 7 (26.9%) | 0 | 0 | 1 (7.7%) | 0 |
| Climbing | 0 | 0 | 1 (7.7%) | 0 | 0 |
| Erecting | 0 | 0 | 0 | 0 | 1 (10%) |
| Dismantling | 1 (3.8%) | 0 | 1 (7.7%) | 0 | 0 |
| Moving Dismantled | 1 (3.8%) | 0 | 0 | 0 | 0 |
| | 26 (100%) | 15 (100%) | 13 (100%) | 13 (100%) | 10 (100%) |
| | | | | | |
| Accident Type | | | | | |
| Fall | 15 (57.7%) | 10 (66.7%) | 11 (84.6%) | 6 (46.1%) | 9 (90%) |
| Collapse | 8 (30.8%) | 5 (33.3%) | 1 (7.7%) | 7 (53.8%) | 1 (10%) |
| Elec. Shock | 1 (3.8%) | 0 | 1 (7.7%) | 0 | 0 |
| Other | 2 (7.7%) | 0 | 0 | 0 | 0 |
| | 26 (100%) | 15 (100%) | 13 (100%) | 13 (100%) | 10 (100%) |
| | | | | | |
| Type Work Performed | | | | | |
| Carpentry | 0 | 2 (13.3%) | 1 (7.7%) | 0 | 0 |
| Steel Work | 2 (7.7%) | 3 (20.0%) | 0 | 0 | 0 |
| Siding | 0 | 1 (6.7%) | 5 (38.5%) | 2 (15.4%) | 1 (10%) |
| Drywall | 3 (11.5%) | 0 | 0 | 0 | 0 |
| Elec. Work | 3 (11.5%) | 0 | 0 | 2 (15.4%) | 0 |
| Concrete Work | 1 (3.8%) | 1 (6.7%) | 0 | 2 (15.4%) | 0 |
| Roofing | 1 (3.8%) | 3 (20.0%) | 2 (15.4%) | 1 (7.7%) | 7 (70%) |
| Other | 3 (11.5%) | 0 | 1 (7.7%) | 2 (15.4%) | 1 (10%) |
| Not Indicated | 13 (50%) | 5 (33.3%) | 4 (30.8%) | 4 (30.8%) | 1 (10%) |
| | 26 (100%) | 15 (100%) | 13 (100%) | 13 (100%) | 10 (100%) |
| | | | | | |
| Causes** | | | | | |
| No guardrails | 3 (11.5%) | 4 (26.7%) | 2 (15.4%) | 3 (23.1%) | 5 (50%) |
| Improper construction | 1 (3.8%) | 5 (33.3%) | 1 (7.7%) | 5 (38.5%) | 0 |
| Unsecure planking | 1 (3.8%) | 2 (13.3%) | 1 (7.7%) | 5 (38.5%) | 0 |
| Poor footing | 6 (23.1%) | 0 | 1 (7.7%) | 0 | 0 |
| Structure breaking | 5 (19.2%) | 6 (40.0%) | 1 (7.7%) | 6 (46.1%) | 1 (10%) |
| Tipping | 4 (15.4%) | 1 (6.7%) | 0 | 0 | 0 |
| Overhead obstruction | 2 (7.7%) | 0 | 1 (7.7%) | 0 | 0 |
| No lifeline | 6 (23.1%) | 3 (20.0%) | 5 (38.5%) | 4 (30.8%) | 9 (90%) |
| Other | 4 (15.4%) | 3 (20.0%) | 2 (15.4%) | 1 (7.7%) | 2 (20%) |
| | | | | | |

* Makeshift scaffolds do not conform to any type described in CFR standards.

** Percentages for causes will not necessarily add to 100% since two causes are assigned to each case.

Table 9: Comparison of Remaining Scaffold Types (continued)

| Scaffold Type / Accident Characteristics | Form | Boatswain | Single-Point Suspension | Tube and Coupler | Outrigger |
|---|---|---|---|---|---|
| Scaffold Use | | | | | |
| Using | 5 (50%) | 9 (90%) | 8 (88.9%) | 3 (37.5%) | 7 (87.5%) |
| Moving Erected | 0 | 1 (10%) | 1 (11.1%) | 0 | 0 |
| Climbing | 2 (20%) | 0 | 0 | 0 | 0 |
| Erecting | 0 | 0 | 0 | 4 (50%) | 1 (12.5%) |
| Dismantling | 3 (30%) | 0 | 0 | 1 (12.5%) | 0 |
| Moving Dismantled | 0 | 0 | 0 | 0 | 0 |
| | 10 (100%) | 10 (100%) | 9 (100%) | 8 (100%) | 8 (100%) |
| | | | | | |
| Accident Type | | | | | |
| Fall | 8 (80%) | 1 (10%) | 2 (22.2%) | 6 (75%) | 5 (62.5%) |
| Collapse | 2 (20%) | 8 (80%) | 6 (66.7%) | 1 (12.5%) | 3 (37.5%) |
| Elec. Shock | 0 | 0 | 0 | 0 | 0 |
| Other | 0 | 1 (10%) | 1 (11.1%) | 1 (12.5%) | 0 |
| | 10 (100%) | 10 (100%) | 9 (100%) | 8 (100%) | 8 (100%) |
| | | | | | |
| Type Work Performed | | | | | |
| Masonry | 0 | 1 (10%) | 1 (11.1%) | 3 (37.5%) | 1 (12.5%) |
| Painting | 0 | 5 (50%) | 1 (11.1%) | 0 | 2 (25%) |
| Siding | 0 | 0 | 0 | 0 | 0 |
| Carpentry | 0 | 0 | 0 | 0 | 2 (25%) |
| Steel Work | 0 | 1 (10%) | 0 | 0 | 0 |
| Concrete Work | 7 (70%) | 0 | 0 | 0 | 1 (12.5%) |
| Other | 2 (20%) | 2 (20%) | 0 | 1 (12.5%) | 0 |
| Not Indicated | 1 (10%) | 1 (10%) | 7 (77.8%) | 4 (50%) | 2 (25%) |
| | 10 (100%) | 10 (100%) | 9 (100%) | 8 (100%) | 8 (100%) |
| | | | | | |
| Causes* | | | | | |
| No guardrails | 0 | 0 | 0 | 1 (12.5%) | 0 |
| Improper construction | 0 | 0 | 1 (11.1%) | 0 | 3 (37.5%) |
| Unsecure planking | 1 (10%) | 0 | 0 | 3 (37.5%) | 1 (12.5%) |
| Poor footing | 0 | 0 | 0 | 0 | 0 |
| Structure breaking | 1 (10%) | 8 (80%) | 6 (66.7%) | 1 (12.5%) | 3 (37.5%) |
| Tipping | 0 | 0 | 1 (11.1%) | 0 | 0 |
| Overhead obstruction | 0 | 0 | 0 | 0 | 0 |
| No lifeline | 3 (30%) | 8 (80%) | 6 (66.7%) | 1 (12.5%) | 2 (25%) |
| Slippery surface | 3 (30%) | 0 | 0 | 0 | 0 |
| Other | 3 (30%) | 2 (20%) | 1 (11.1%) | 1 (12.5%) | 3 (37.5%) |

* Percentages for causes will not necessarily add to 100% since two causes are assigned to each case.

Table 9: Comparison of Remaining Scaffold Types (continued)

| Scaffold Type / Accident Characteristics | Wood Pole | Mason's Multi-Point Suspension | Crawling or Chicken Board | Float or Ship | Interior Hung |
|---|---|---|---|---|---|
| Scaffold Use | | | | | |
| Using | 5 (83.3%) | 2 (50%) | 3 (100%) | 2 (100%) | 1 (50%) |
| Moving Erected | 0 | 0 | 0 | 0 | 0 |
| Climbing | 0 | 0 | 0 | 0 | 0 |
| Erecting | 0 | 1 (25%) | 0 | 0 | 0 |
| Dismantling | 1 (16.7%) | 1 (25%) | 0 | 0 | 1 (50%) |
| Moving Dismantled | 0 | 0 | 0 | 0 | 0 |
| | 6 (100%) | 4 (100%) | 3 (100%) | 2 (100%) | 2 (100%) |
| | | | | | |
| Accident Type | | | | | |
| Fall | 4 (66.7%) | 2 (50%) | 2 (66.7%) | 2 (100%) | 2 (100%) |
| Collapse | 2 (33.3%) | 1 (25%) | 1 (33.3%) | 0 | 0 |
| Elec. Shock | 0 | 0 | 0 | 0 | 0 |
| Other | 0 | 1 (25%) | 0 | 0 | 0 |
| | 6 (100%) | 4 (100%) | 3 (100%) | 2 (100%) | 2 (100%) |
| | | | | | |
| Type Work Performed | | | | | |
| Masonry | 0 | 2 (50%) | 0 | 0 | 0 |
| Painting | 0 | 0 | 1 (33.3%) | 0 | 1 (50%) |
| Steel Work | 0 | 0 | 0 | 1 (50%) | 0 |
| Carpentry | 1 (16.7%) | 0 | 0 | 0 | 0 |
| Roofing | 0 | 0 | 1 (33.3%) | 0 | 0 |
| Other | 1 (16.7%) | 0 | 0 | 0 | 0 |
| Not Indicated | 4 (66.7%) | 2 (50%) | 1 (33.3%) | 1 (50%) | 1 (50%) |
| | 6 (100%) | 4 (100%) | 3 (100%) | 2 (100%) | 2 (100%) |
| | | | | | |
| Causes* | | | | | |
| No guardrails | 2 (33.3%) | 1 (25%) | 1 (33.3%) | 1 (50%) | 0 |
| Improper construction | 3 (50%) | 0 | 1 (33.3%) | 0 | 0 |
| Unsecure planking | 0 | 0 | 0 | 0 | 0 |
| Poor footing | 0 | 0 | 0 | 0 | 0 |
| Structure breaking | 2 (33.3%) | 0 | 1 (33.3%) | 0 | 1 (50%) |
| Tipping | 0 | 0 | 0 | 0 | 0 |
| Overhead obstruction | 0 | 0 | 0 | 0 | 0 |
| No lifeline | 1 (16.7%) | 0 | 2 (66.7%) | 1 (50%) | 1 (50%) |
| Slippery surface | 0 | 1 (25%) | 0 | 0 | 0 |
| Other | 0 | 4 (100%) | 0 | 1 (50%) | 1 (50%) |

* Percentages for causes will not necessarily add to 100% since two causes are assigned to each case.

Table 9: Comparison of Remaining Scaffold Types (continued)

| Scaffold Type / Accident Characteristics | Bricklayer's Square | Horse | Needle Beam | Horizontal Wire Suspension * | Non-Descriptive in Abstract ** |
|---|---|---|---|---|---|
| Scaffold Use | | | | | |
| Using | 2 (100%) | 1 (100%) | 1 (100%) | 1 (100%) | 79 (76.0%) |
| Moving Erected | 0 | 0 | 0 | 0 | 3 (2.9%) |
| Climbing | 0 | 0 | 0 | 0 | 6 (5.8%) |
| Erecting | 0 | 0 | 0 | 0 | 8 (7.7%) |
| Dismantling | 0 | 0 | 0 | 0 | 6 (5.8%) |
| Moving Dismantled | 0 | 0 | 0 | 0 | 1 (1.0%) |
| Not Indicated | 0 | 0 | 0 | 0 | 1 (1.0%) |
| | 2 (100%) | 1 (100%) | 1 (100%) | 1 (100%) | 104 (100%) |
| | | | | | |
| Accident Type | | | | | |
| Fall | 2 (100%) | 1 (100%) | 1 (100%) | 0 | 72 (69.2%) |
| Collapse | 0 | 0 | 0 | 1 (100%) | 23 (22.1%) |
| Elec. Shock | 0 | 0 | 0 | 0 | 1 (1.0%) |
| Other | 0 | 0 | 0 | 0 | 8 (7.7%) |
| | 2 (100%) | 1 (100%) | 1 (100%) | 1 (100%) | 104 (100%) |
| | | | | | |
| Type Work Performed | | | | | |
| Masonry | 1 (50%) | 0 | 0 | 0 | 25 (24.%) |
| Painting | 0 | 0 | 1 (100%) | 1 (100%) | 6 (5.8%) |
| Siding | 1 (50%) | 1 (100%) | 0 | 0 | 3 (2.9%) |
| Drywall | 0 | 0 | 0 | 0 | 4 (3.8%) |
| Carpentry | 0 | 0 | 0 | 0 | 6 (5.8%) |
| Concrete | 0 | 0 | 0 | 0 | 16 (15.4%) |
| Other | 0 | 0 | 0 | 0 | 37 (35.6) |
| Not Indicated | 0 | 0 | 0 | 0 | 7 (6.7%) |
| | 2 (100%) | 1 (100%) | 1 (100%) | 1 (100%) | 104 (100%) |
| | | | | | |
| Causes** | | | | | |
| No guardrails | 0 | 0 | 0 | 0 | 14 (13.5%) |
| Improper construction | 1 (50%) | 0 | 0 | 0 | 9 (8.7%) |
| Unsecure planking | 0 | 0 | 0 | 0 | 24 (23.1%) |
| Poor footing | 0 | 1 (100%) | 0 | 0 | 12 (11.5%) |
| Structure breaking | 0 | 0 | 0 | 1 (100%) | 13 (12.5%) |
| Tipping | 1 (50%) | 0 | 0 | 0 | 2 (1.9%) |
| Overhead obstruction | 0 | 0 | 0 | 0 | 4 (3.8%) |
| No lifeline | 0 | 0 | 1 (100%) | 1 (100%) | 20 (19.2%) |
| Slippery surface | 1 (50%) | 0 | 0 | 0 | 8 (7.7%) |
| Other | 0 | 1 (100%) | 0 | 0 | 23 (22.1%) |

* Horizontal wire suspension scaffold is designed for travelling horizontally along the cable suspending the scaffold. It is used typically in bridge painting operations.

** Insufficient information existed in the abstract to identify the scaffold involved with the accident.

** Percentages for causes will not necessarily add to 100% since two causes are assigned to each case.

As might be expected, each type of construction work performed seems to focus on one type of scaffold which best meets the needs of the operation. The causes associated with each scaffold type seem to reflect this variation of their uses in construction. The most frequent causes of accidents portray the weaknesses of each of the scaffold types. The tubular welded frame scaffold has problems being constructed properly which includes missing guardrails, unsecure planking and miscellaneous missing parts. Manually-propelled scaffolds have problems with no guardrails being installed and tipping/overhead obstruction hazards. Swinging scaffolds have problems with failure to use lifelines and breaking of suspension ropes. Aerial lifts have problems with failure to use lifelines and contacting overhead obstructions. Pump jack scaffolds have problems primarily with structural breaks and improper construction.

**Floor and Wall Openings**

Floor and wall openings were involved in 394 cases of which 73.4% were fatality cases. Openings were segregated by the general size of the opening or an open-sided area as listed below. Since the sizes of openings varied greatly, the size of opening was converted to an area in square feet for purposes of categorization and comparison. For example, a opening recorded as 2'x6' was converted to 12 square feet and categorized as between 3'x3' and 6'x6'.

Opening Size Categories:

- 3'x3' or smaller (< 9 square feet)
- Between 3'x3' and 6'x6' (between 9 and 36 square feet)
- 6'x6' or larger (> 36 square feet)
- Open-sided floors or platforms

Open-sided floors accounted for 41.4% of all opening cases and 43.3% of the opening fatality cases (see Figure 71). The next most frequent category was 9 to 36 square feet of floor opening (or square dimensions between 3 and 6 feet) accounting for 17.8% of all

cases and 17.0% of the fatality cases. Unfortunately, 24.9% of the cases involving openings did not indicate the size.

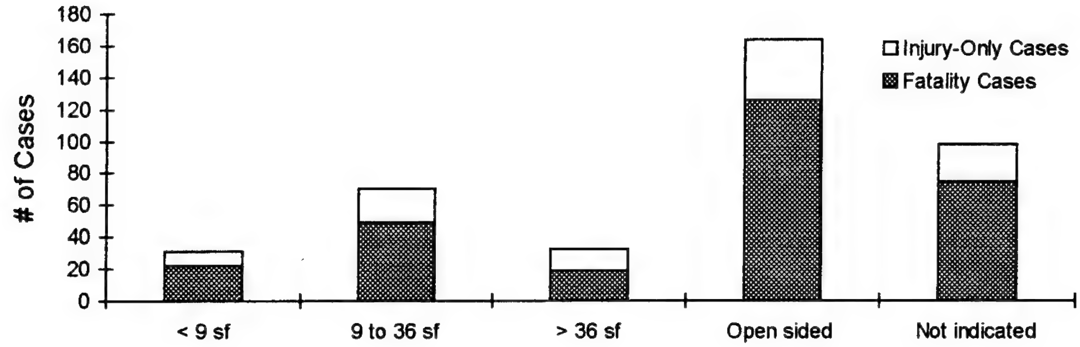


Figure 71: Opening Cases by Size of Opening

The type of work performed at the time of the accident varied between many different trades, but was dominated by roofing operations. Roofing accounted for 34.5% of all cases and 39.1% of the fatality cases (see Figure 72). Interestingly, 60.0% of the roofing cases were related to open-sided accidents and 28% were related to floor size openings between 9 and 36 sf. In many cases, these openings were skylights in which workers accidentally fell into the skylight or purposely sat or stepped on the skylight expecting the transparent covering to hold them. The next most frequent type of work was carpentry accounting for 10.4% of all cases and 6.9% of the fatality cases.

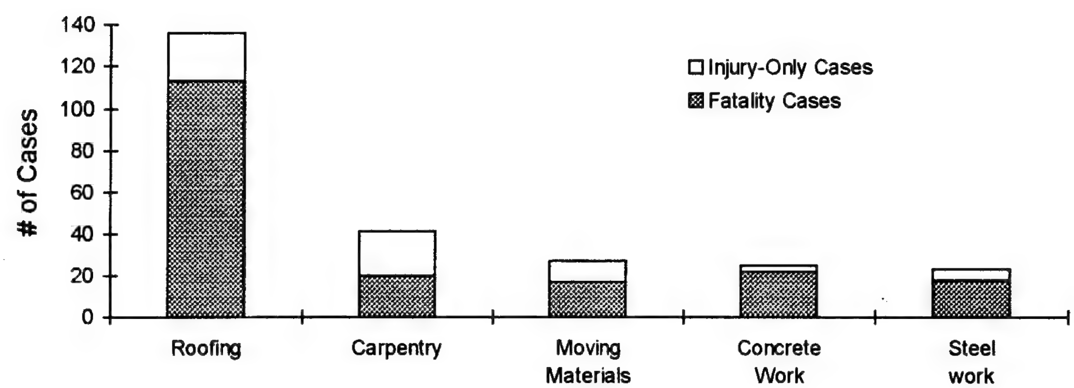


Figure 72: Opening Cases by Type of Work Performed

As might be expected, opening accidents were almost completely fall-related incidents accounting for 99.0% of the cases. Three major types of falls can be observed in the data (see Figure 73). Falls through floor openings/edges is the most common form of opening accident accounting for 53.3% of the cases and 52.2% of the fatality cases. This category includes part of the cases previously classified as open-sided openings (i.e. falls from floor edges), as well as other opening sizes. The next most frequent fall incident was from a roof edge accounting for 27.4% of the cases and 29.4% of the fatality cases. This category was entirely categorized as open-sided accidents. Wall openings comprised a smaller portion accounting for only 12.2% of the cases and 11.8% of the fatality cases.

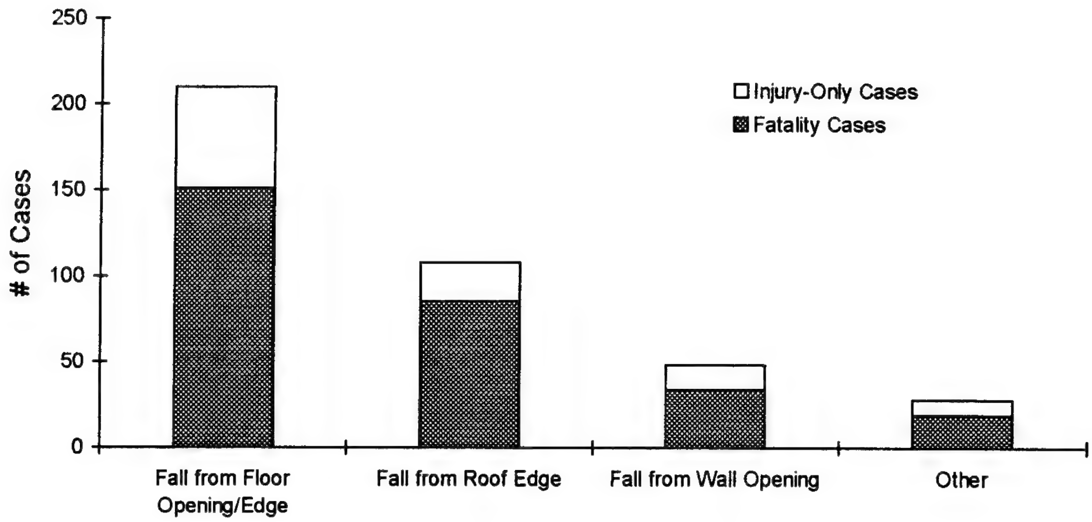


Figure 73: Opening Cases by Type of Accident

The causes of opening accidents were fairly basic and generally involved a lack of an appropriate guard for the opening, contributing to 44.9% of the cases and 42.5% of the fatality cases (see Figure 74). While the type of guard for the opening could consist of many items, 26.1% of the cases and 26.0% of the fatality cases specifically indicated that guardrails were missing. The lack of a lifeline or safety net was a cause for 23.9% of the cases and 26.0% of the fatality cases. In 9.9% of the cases and 11.8% of the fatality cases, covers were provided over the openings but failed to protect by breaking under the load of the worker. Similarly, in 8.1% of the cases and 6.9% of the fatality cases, coverings were provided over the openings but failed to protect by moving out of place.

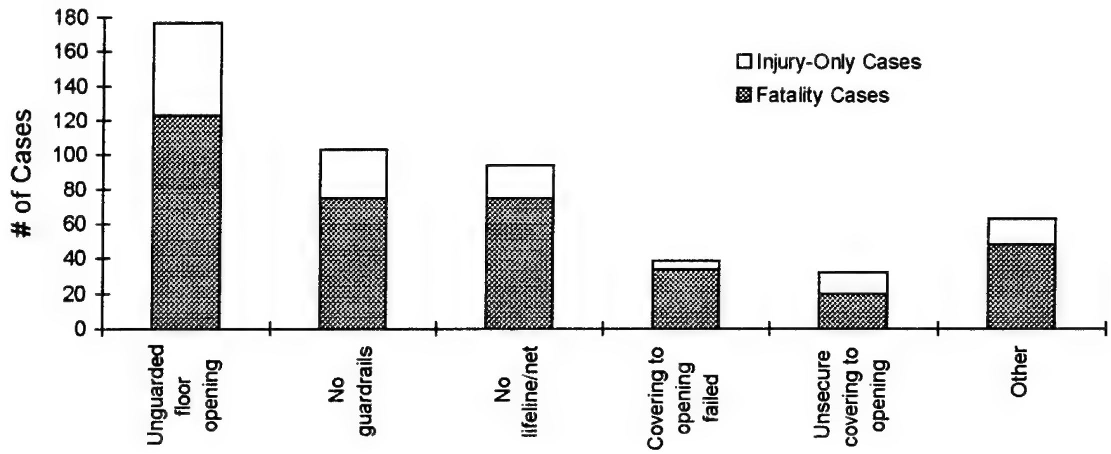


Figure 74: Opening Cases by Causes

Causes attributed to the working environment and human factors varied only slightly from the causes attributed to scaffolds in Figures 48 and 49. "Misjudgment of the hazard" was cited as the most frequent of the human causal factors accounting for 40.4% of the cases and 39.1% of the fatality cases (see Figure 75). The removal of safety devices such as lifelines or guardrails accounted for 15.0% of the cases and 15.2% of the fatality cases. As might be expected, the category "working surface of facility layout condition" under working environment accounted for 78.2% of the opening cases and 77.2% of the fatality cases (see Figure 76).

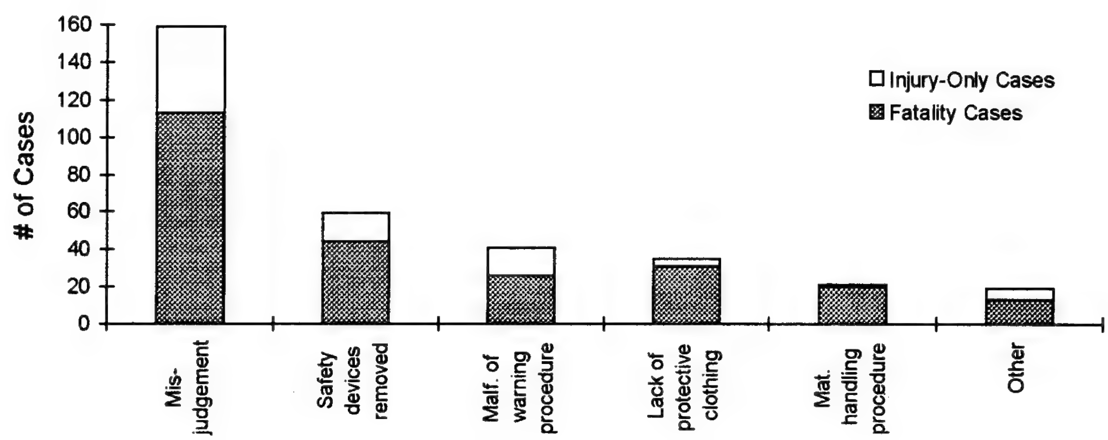


Figure 75: Opening Cases by Human Causal Factors

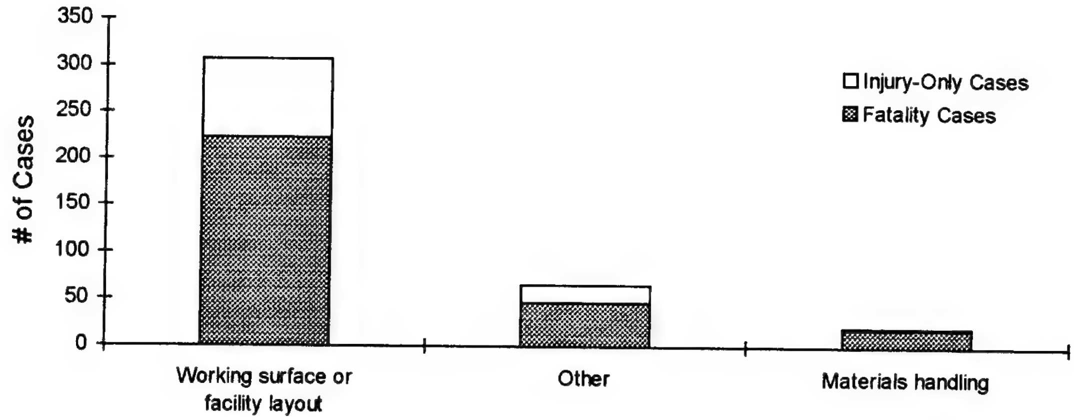


Figure 76: Opening Cases by Environmental Causal Factors

The most frequently cited 29 CFR 1926.500 paragraph standard was the lack of guardrails on the exposed sides of the floor openings. This and other citations seem to correlate well with the causal indicators reviewed previously for openings. The seven most frequently cited 29 CFR 1926.500 paragraphs are listed in Table 10. Of special note, paragraph 500(e)(1) is no longer listed in the 29 CFR 1926, requiring handrails on stairwells.

Table 10: Top Seven 29 CFR 1926.500 Paragraph Citations for Opening Cases

| 29 CFR 1926 | Description | # of Fatality Cases (%) | # of Injury-Only Cases (%) |
|---|---|---|---|
| 500(b)(1) | Guardrails on all exposed sides of floor openings. | 83 (28.7%) | 28 (26.7%) |
| 500(d)(1) | Open-sided floor/platform to be guarded. | 76 (26.3%) | 29 (27.6%) |
| 500(g)(1) | Roof work edge protection or warning system. | 41 (14.2%) | 4 (3.8%) |
| 500(g)(6) | Training program for falling hazards during roof work. | 41 (14.2%) | 7 (6.7%) |
| 500(g)(5) | Protection of materials handling areas of roof edges. | 32 (11.1%) | 2 (1.9%) |
| 500(b)(4) | Skylights guarded by rails or cover. | 27 (9.3%) | 4 (3.8%) |
| 500(e)(1)* | Stair flights equipped with handrails* | 23 (8.0%) | 9 (8.6%) |

* Paragraph not included in July 1, 1994 edition of 29 CFR 1926.

**Victim Characteristics**

Information about each of the injured or deceased workers was recorded and included age, disposition of the injury, nature of the injury, and part of the body involved in the injury. This database was organized to record up to 6 victims per case. The mean age for all 1,313 victims recorded in the 1,030 cases was computed and compared to the mean age of the first recorded victim in each case (see Table 11). Since these figures vary by very little the assumption is made that the data for first victim in each case is representative of the entire population of victims in this database for the purposes of these comparisons. This assumption is made because of the limitations of the SPSS database program in order to simplify the calculations of the mean, mode, and median ages, as well as frequencies of injury nature and part of body affected.

As noticed in Table 11, the typical age for a fatality is higher than other non-fatal injuries. This indicates that older workers may be slightly more vulnerable to more serious injuries than younger workers. This does not discount that experience and wisdom gained with age can undoubtedly prevent many accidents from happening, or the lack of experience can lead to the development of an accident. In fact, the lower age observed for floor/wall opening accidents may indicate that the lack of experience of younger workers has lead to a larger number of younger victims involved in these accidents.

Table 11: Comparison of Victim Ages (years)

| | Mean Age | Mean Age of 1st Victim | Mode Age of 1st Victim | Median Age of 1st Victim |
|---|---|---|---|---|
| All Cases | 35.1 | 35.8 | 26 | 33 |
| Fatality Cases | 37.7 | 37.8 | 26 | 35 |
| Hospitalized Cases | 32.3 | 32.1 | 26 | 29 |
| Non Hospitalized Cases | 33.1 | 33.6 | 23 | 31 |
| Scaffold Cases | | 36.1 | 26 | 33 |
| Opening Cases | | 35.3 | 24 | 32 |

If the mean age of the first victim of each fatality case is compared to the working elevation (or height) of the case, an interesting trend is noticed (see Figure 77). As the

working elevation rises, the mean age of the victim decreases. This would indicate younger workers typically work at higher elevations or are better able to withstand potentially fatal injuries at the lower working elevations.

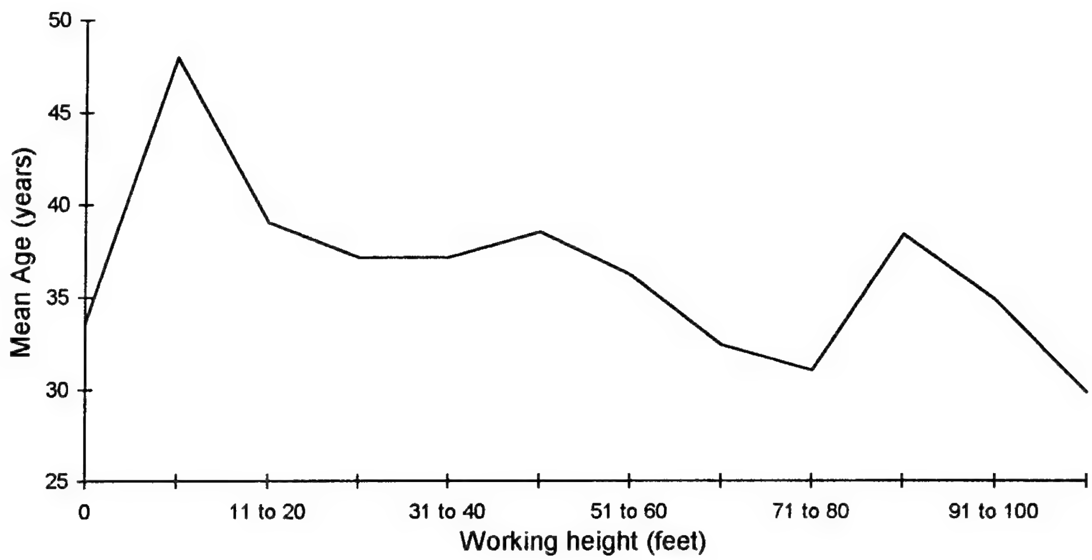


Figure 77: Mean Age of First Victim by Working Elevation

The nature of the victim's injury whether fatal or not tended to focus on 5 classifications (see Figure 78). The most frequent was fractures accounting for 42.4% of the cases and 33.2% of fatality cases. Again, the "other" category was used frequently by compliance officers for 19.4% of all cases and 26.9% of the fatality cases. Unfortunately, little information can be gained from this classification. Not surprisingly, categories for concussion and electrical shock have a high percentage of fatalities. Obviously, injuries of this nature are very serious and commonly result in death for the victim. The relative rankings of these categories did not vary when comparing scaffold and floor/wall opening cases except in one category. Electrical shock was not a significant type of injury involved with floor/wall opening accidents.

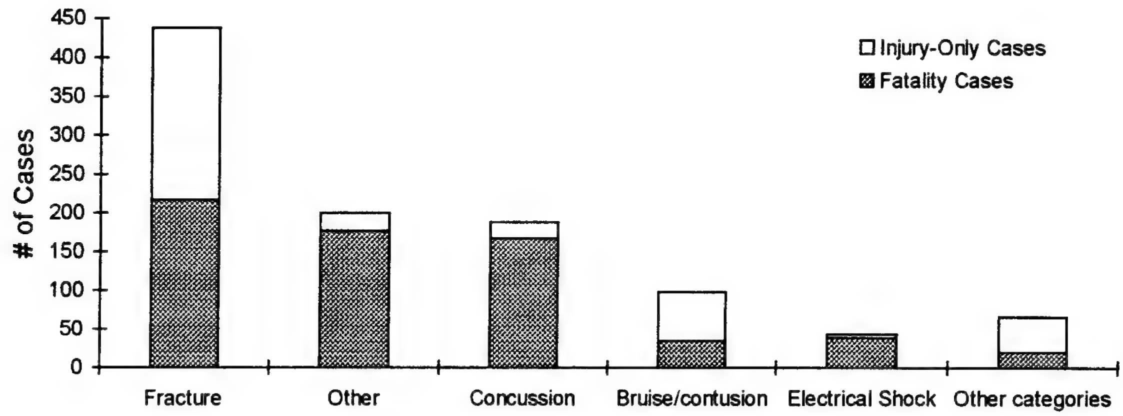


Figure 78: Cases by Nature of Victim's Injury

The part of the body injured in most cases was the head, accounting for 35.5% of all cases and 49.1% of all fatality cases (see Figure 79). Since falls were the major type of accident, it is reasonable to expect injuries to the head and multiple injuries will be significant. Body system injuries were fatalities in 86.5% of the instances which typically was used to classify electrical shocks. The category for "other body system" also reflects a high fatality rate at 78.6%. However, it is not clear how the category "other body system" differs from "body system." Again, the relative rankings of these categories did not vary when comparing scaffold and floor/wall opening cases except for one category. Injuries to the feet were not a significant factor involved with floor/wall opening accidents.

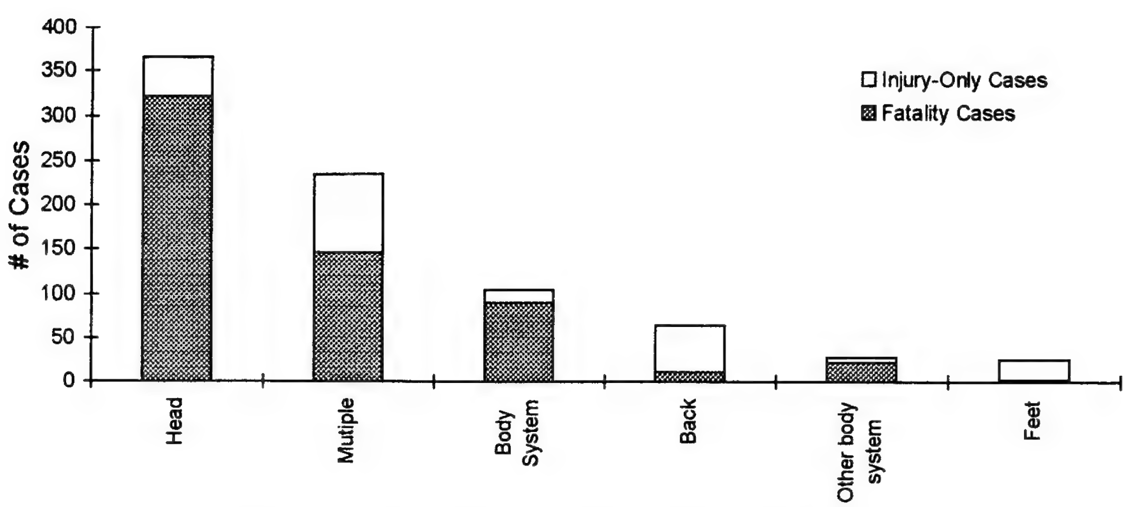


Figure 79: Cases by Part of Victim's Body Injured

# Chapter 4

# Conclusions and Recommendations

## General Accident Conclusions

As with most construction accidents, scaffold and floor/wall opening accidents occur most often during the mid-morning and mid-afternoon hours of the work day. This may be due to the pace of work activity being at its highest which may add to the amount of fatigue affecting workers. A pattern of accident occurrences is also observed during the months in the year. Scaffold and opening related-accidents occur most often during the summer months when the pace of construction activity is at its highest. One exception is noted for a significant increase in accidents occurring in October. Further research will be required to identify the cause of this phenomenon.

Southern states report about half as many accidents compared to northern states, but have more fatality accidents. Southern states also show a sharp decrease in accidents in September which highlights the increase of accidents in October. The data prevented detailed analysis by states because many states are not represented in the IMIS database for all years. If the October peak was related to changing seasonal weather, the October peak should have been less pronounced in the southern regions.

The IMIS database showed a dramatic decline in cases reported in more recent years indicating a problem in reporting. No identified event around 1988/89 was found to cause the safety of scaffolds and openings to improve substantially by 1990. Further research will be required to identify the cause of declining accidents to less than half of its previous level. Approximately 15 states have continued to regularly report each year since 1990. The number of accidents recorded in comparison to the fatalities per million workers per year would indicate that many states are not reporting accidents to the IMIS on a regular basis. This lack of reporting is not believed to be related to the state-plan states since the number of these states reporting each year also declined to half of the previous level.

The lack of detailed information in the case abstracts and frequent use of "other" categories to describe some datafields indicates that many OSHA compliance officers are not properly trained to record accident data for the IMIS. Frequent use of general description categories such as "other" also indicate limited choices for categorizing the datafield and lead to generalized analysis results unable to pin-point specific conclusions.

Companies involved in scaffold and floor/wall opening accidents are generally small and have less than 10 employees. The large frequency of accidents involving small companies size could be explained by a large number of small firms in the construction industry. It might also be argued that larger companies have better project safety programs as fewer accidents are recorded with an increase in the number of employees. The percentage of fatality accidents, however, increases with company size demonstrating that accidents, while rare, are more likely to be serious in a larger firm. Many other factors may be involved that would influence accident rates for differently sized companies, therefore, more research would be required to draw conclusive relationships between company size and accidents.

When a larger company does have an accident, it will most likely pay a higher fine for violations of the 29 CFR 1926. The reason for this is not clear since the fewer accidents reported would indicate better safety programs. The higher fines per accident may be related to the fact that larger companies are "expected to know better" as compared to smaller companies or that they have the capacity to pay larger fines. Another explanation is related to the previously mentioned possibility that the few accidents occurring to larger companies are more serious in nature than most accidents involving small companies. However, considering that half of all fatality cases involved companies with fewer than 8 employees, larger companies seem to be paying more than their share in fines.

Since 93.4% of the cases involved falling from an elevation, the elevation can be considered key to determining the occurrence and seriousness of the injury. Most

accidents, either fatal or non-fatal, occur between an elevation of 10 and 50 feet as this represents the most frequently used elevations in construction involving scaffolds or floor/wall openings. As the elevation rises, the probability of a fatality in an accident increases. Thus, as working platforms increase in elevation, more attention should be given to safety aspects of the operation, particularly related to fall protection.

**General Accident Recommendations**

Employers and federal/state OSHA organizations should consider the following recommendations:

- Construction contractors should be encouraged to implement and maintain strong safety programs. A positive safety conscious attitude beginning with the employer will help ensure all workers take safety seriously. A regular training program showing workers how to recognize hazards will help eliminate the sometimes simple mistakes which lead to accidents.

- Allow adequate rest breaks to reduce fatigue. Fatigue is possibly a factor in all accidents. Allowing adequate rest during the day will increase production in the long term by avoiding accidents in the short term.

- Pay attention to safety in the summer and the months of September and October. While no specific cause to the fluctuations in accident occurrences for September and October is apparent, sufficient data exists to warrant special attention to safety during these months.

- Federal and state safety agencies should enforce regular reporting of accidents to the federal level. All states should be required to report all cases annually. Without a complete database, analysis of the information will not lead to accurate conclusions and decisions to improve safety.

- Federal and state safety agencies need to train compliance officers to record accident details in a standardized format to ensure complete information is included in the IMIS database. Details in the abstract vary greatly and commonly miss critical information which could help point to the cause of an accident. Likewise, some datafields

in the IMIS are not accurately coded. Just as recording all accidents in the database is important, recording complete details on each accident will further strengthen the conclusions made from this data.

- Future searches for information with the IMIS database should be done with a dual search strategy to ensure complete selection of applicable cases. Without this strategy valid data may be overlooked and possibly cause inaccurate or inconclusive results.

- Federal and state safety agencies should enforce standards with consistent amounts of fines for comparable violations. It seems that if fines are to work as a deterrent to poor safety practices, small companies need to be fined at the same amounts that larger companies would be charged for similar violations. Focus enforcement efforts on smaller companies which represent the major portion of accidents. Additional research investigating the relationships between company size and accidents may be useful in these efforts.

**Scaffold Accident Conclusions**

In order to prevent falls from occurring, it is necessary to know the causes of falls. For scaffolds, the general causes are not wearing a lifeline when required and not properly constructing scaffolds. The major causes of scaffold accidents, as discovered in this study, are no guardrails, improper construction such as missing bracing, unsecure/weak planking, and poor footing support. These deficiencies lead to falls from scaffold platforms or collapses of scaffolds resulting in falls.

A significant part of these deficiencies can be related to an employers general safety program in addition to the specific problems of the scaffolding. Injuries resulting from deficiencies in training programs of employees, failure to inspect work site conditions, and not enforcing the wearing of personal protective equipment have all contributed to the development of a job site attitude where personnel do not concentrate on safety.

Tubular welded frame scaffolds are the most popular type of scaffold in use in construction, particularly with masonry construction. Falls from this type of scaffold were mainly due to the lack of guardrails or unsecure planking. Collapses were due to improper construction of the scaffold (usually missing bracing members) and poor footing support.

Manually-propelled mobile scaffolds were most popular with drywall installers, painters, and, to a lesser extent, electricians. Falls related to this scaffold appear to be due to the lack of guardrails and unsecure planking. Collapses of this scaffold came mostly from tipping over, caused by poor footing, improper movement, and unlocked wheels. Electrical shock was also a significant contributor to accidents when the scaffold was moved into overhead power lines.

Painting dominates the usage of two-point suspension scaffolds. Because of the higher working elevations encountered with the use of this scaffold, a higher percentage of fatalities occurred compared to other scaffold types. Falls and collapses accounted for virtually all accidents related to this scaffold. The lack of a lifeline was the most significant cause of these accidents. Even though collapses were most frequently caused by the structure support breaking, the use of lifelines in those situations would have prevented the victims from falling.

Extensible and articulating boom aerial lifts were used most often for electrical work and less frequently for painting. Though falls were the most common type of accident, a significant number were due to electrical shock primarily due to contact with overhead power lines. The most common causes of accidents related to this scaffold type were the inattention to overhead obstructions and the lack of a lifeline.

Siding installation dominated the type of work related to pump jack scaffold accidents. These accidents occurred primarily in residential construction. Pump jack scaffolds suffered mostly from collapses which were caused by the breaking of the main structural

supports, the wooden poles. While the 29 CFR 1926 allows the lifeline as an option to guardrails, the use of lifelines is to be preferred to prevent workers from falling with the scaffold, acknowledging that collapses are most common with this system.

**Floor/Wall Opening Conclusions**

Floor/wall opening accidents were comprised mostly of falls from open-sided floors or platforms which were mostly associated with roofing operations. Floor opening sizes typically ranged in size from 9 to 36 square feet. Many floor opening accidents were associated with workers falling through existing skylights during roofing operations.

Causes of floor/wall opening accidents were generally due to an unguarded floor opening, a lack of guardrails or a lack of a lifeline while working near an opening. In many situations where coverings were provided, the covering failed to hold the weight of the worker (such as with the skylights) or was unsecured and moved to expose the worker to a fall hazard.

**Scaffold and Floor/Wall Opening Recommendations**

To prevent scaffold or opening related accidents from occurring, or to minimize injuries should an accident occur, employers and federal/state OSHA organizations should consider the following:

- Use a lifeline. Though not all scaffolds require their use by the CFR, use of the lifeline/safety belt combination can greatly reduce the risk of serious fall-related injury. Its use is minimally inconvenient to production and should be considered for any scaffold situation where guardrails are not used or where the working elevation exceeds 15 feet. When using swinging or pump jack scaffolds, a lifeline should be used due to the frequency of structural failures. Lifelines should also be used when working at an open-sided floor/platform.

- Install proper guardrails. Though not structurally important for the scaffold, it provides a vital barrier between the worker and the edge of the platform. Having guardrails lets the worker concentrate on the work without worrying about backing over the edge.

- Construct scaffolds properly. This includes secure and strong planking, proper bracing, and sound footing. Scaffolds are already designed for minimal construction material. Short-changing this material will significantly decrease its rigidity.

- Check overhead obstructions prior to moving/erecting any scaffold. Electrical shock from power lines is the main concern, but other obstructions can cause scaffolds to tip over.

- Use secured covers for floor/wall openings, when possible. Materials should be strong enough to withstand the force of a worker and be secure to prevent accidental movement. Coverings, when feasible, are better protection than guardrails in most situations because more of the opening can be covered.

- Check and guard opening hazards during roofing operations. Roofing is the one type of construction work which will consistently have opening hazards existing either as rectangular floor openings or open-sided roof edges.

- Give special attention to inspections of the structural members of swinging and pump jack scaffolds. Because of the high frequency of collapses related to these scaffold types the suspension system on the swinging scaffolds and the poles of the pump jack scaffold should be carefully inspected for defects prior to each and every use.

## BIBLIOGRAPHY

29 Code of Federal Regulations, Part 1926, Office of the Federal Register National Archives and Records Administration, revised July 1, 1994

44 Ill. App. 3d 839, 358 N.E.2d 1254 (1976), rev'd. 71 Ill. 2d 111, 373 N.E.2d 1348 (1978), further proceedings, 85 Ill. App. 3d 247, 406 N.E.2d 218 (1980) *Construction Industry Contracts: Legal Citator and Case Digest*, New York: Wiley, 1988, pp.462-470

100 Neb. 491, 206 N.W.2d 834 (1973)

443 N.E.2d 1212 (Ind. Ct. App. 1983)

625 P.2d 51 (Mont. 1981)

*1987 Census of Construction Industries*, US Dept. of Commerce, CC87-A-10, issued Oct. 1990

"Construction Union Membership...", *BNA Construction Labor Report*, Vol. 40, No. 2018, Feb. 15, 1995, p1237

"Dear Says OSHA Examining Job Safety..." *BNA Construction Labor Report*, Dec 7, 1994, v40 p958

"Denver-Area Residential Boom ..." *BNA Construction Labor Report*, Jan 12, 1994, v39 p1208

"ENR News" *Engineering News Record*, Aug 31, 1989, p14

"ENR News" *Engineering News Record*, Oct 11, 1993, p12

Hinze, J., *Construction Contracts*, New York-McGraw-Hill, 1993, p.311

Hinze, J. and Bren, K., "Identifying Construction Areas of Need for Safety Research," *J. of Const. Engineering and Management*, ASCE, Vol 122, No.1, (to be published)

Hinze, J. and Russell, D., "Analysis of Fatalities Recorded by OSHA", *J. of Construction Engineering and Management*, ASCE, Vol 121, No. 2, June 1995, p209

Helander, M. ed., *Human Factors/Ergonomics for Building and Construction*, New York: Wiley, 1981, p13 & 40

Howell, Lembhard G., "Construction Site Accidents: How OSHA Affects their Litigation" *Trial*, March 1985, p18-23

"Judge Doubles Proposed Penalties..." *BNA Construction Labor Report*, Sept 9, 1992, v38, p725

Ireton, K. ed. "Scaffolding - What Goes Up Mustn't Come Down Accidentally", *Fine Homebuilding*, Dec-Jan 1987, n36 p37

"Legal Perspectives: Who is Liable for Construction Safety" *Architectural Record*, October 1983, p41

Levin, K. I. et al. *Construction Litigation*, New York: Practicing Law Institute, 1993, p309

NIOSH Alert No. 92-108, as cited in "Scaffold Falls Could Be Prevented..." *BNA Construction Labor Report*, Feb. 10, 1993, v38 p1417

"OSHA to Open Record on Scaffold Proposal" *BNA Construction Labor Report*, Jan 12, 1994, v39 p1206

"OSHA Issues Final Fall Protection Standard..." *BNA Construction Labor Report*, Aug. 10, 1994, v40 p585

OSHRC, No. 91-0600, 11/4/93, as cited in "Labor Secretary Need Not Prove Hazard..." *BNA Construction Labor Report*, Nov 17, 1993, v39 p1018

Rossnagel, W.E., et al., *Handbook of Rigging for Construction and Industrial Operations*, New York: McGraw-Hill, 1988, p379 & 394

"Scaffold Falls Could Be Prevented" *BNA Construction Labor Report*, Feb 10, 1993, v38 p1417

"Scaffold Supplier Not Liable..." *BNA Construction Labor Report*, Dec. 18, 1991, v37 p1129

Smith, R.J., "Contractual and Legal Considerations With Respect to Temporary Structures" *Temporary Structures in Construction Operations*. Ed. R.J. Ratay, New York: American Society of Civil Engineers, 1987. p9-12.

"Subcontractor at Multi-Employer Site..." *BNA Construction Labor Report*, Jan 15, 1992, v37 p1222

Texas Ct. App., No. 01-91-00224-CV, 11/21/91 as cited by "Scaffold Supplier Not Liable..." *BNA Construction Labor Report*, Dec. 18, 1991, v37 p1129

US Ct. App. CA 6, No. 91-3366, 12/20/91 as cited by "Subcontractor at Multi-Employer Site..." *BNA Construction Labor Report*, Jan 15, 1992, v37 p1222

## APPENDIX A

Sample of OSHA's
Integrated Management Information System (IMIS)
Record of Accidents

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
SEARCH OF ALL FEDST ACCIDENT INVESTIGATIONS FROM JAN 85 TO JAN 95
FOR ("BSCAFFOLD") OR ("BAERIAL LIFT") OR ("BWALL OPENING") OR ("BFLOOR OPENING")

```
ESTABLISHMENT INSPECTED          REPORT ID ACTIVITY# CSHO      SIC1/SIC2
ADDRESS                          OPEN DATE INSP TYPE CATEGORY  $PEMITTED  EMPESTAB
CITY                 STATE ZIP   CLOSECONF OPT REPT# SCOPE     OWNERSHIP  EMPINSP    LWDI
COUNTY (NAME/CODE)               CASE CLSD PREV ACT  UNION     CLASS      EMPCNTRL
                                           RELTD ACT

                                              GR                      ART                          INITIAL             CURRENT C SETTLM-T HAZD
                                  CITATION    RE ISSUANCE    ABATE    CMP  INITIAL    CURRENT     F-T-A              F-T-A   N DISPOS-N SUBS
          STANDARD                TYP IDENT   VC   DATE      DATE     CDE  PENALTY    PENALTY     PENALTY            PENALTY T /FINORDT CODE

*******************************
LAWRENCE R. WOHL, INC.           0213100   017805699 R8604-C  1721         15.5       6.0   6.0           3.5
I.B.M. BLDG 316 ROUTE 52           7/01/85 UN-FATCAT SAFETY   320          10
FISHKILL             NY 12533      7/11/85 79-85     COMPREH  PRIV SEC      4
DUTCHESS                027        6/06/86  (NONE)   UNION    SPG-CONST    23  (PENALTIES PAID)
                                           A360526057
OPT-INFO: N-01 017805706

        1926.451 A14              S 01001          8/01/85   8/03/85 X    640         320            0             0   Y R-050186

                                      ****    ACCIDENT DATA    ****
```

SUMMARY # 14484091 DATE: 6-21-85 KEYWDS:FALL DESCRIP:FALL TO CONCRETE FLOOR
ABSTRACT: A PAINTER WAS WORKING FROM A 12 INCH WIDE SCAFFOLD PLATFORM WHICH WAS ABOUT 18 FEET ABOVE THE CONCRETE FLOOR. HE APPARENTLY UNTIED THE LANYARD OF HIS SAFETY BELT FROM AN OVER HEAD PIPE AND STARTED TO MOVE TO ANOTHER LOCATION. HE SLIPPED AND FELL TO THE CONCRETE FLOOR. HE WAS FATALLY INJURED. ---(ABSTRACT WAS REVIEWED)

```
            VICTIM: 001                          AGE: 26         SEX: M
                 DISPOSITION : FATALITY                          EVENT-TYPE  : FALL(FROM ELEVATION)
                 INJ NATURE  : FRACTURE                          ENVIR FACTOR: OTHER
                 INJ SOURCE  : WORKING SURFACE                   HUMAN FACTOR: MISJUDGMENT, HAZ. SITUATION
                 PART-OF-BODY: ABDOMEN                           HAZ SUBSTNCE: NO SUBSTANCE IMPLICATED
*******************************
ROLLINS ASSOCIATES, INC.         0213100   100709609 58329-C  1521         54.0  1.0  16.5  18.5        11.0  7.0
CARPENTER HILL RD.                 1/13/98 UN-FATCAT SAFETY   420           4
STANFORDVILLE        NY 12581      1/21/98 382-88    PARTIAL  PRIV SEC      4
DUTCHESS                027       11/15/98 A360525993 UNION   SPG-CONST     7  (PENALTIES PAID)
                                           A360525893

        1926.021 B02              S 01001          2/24/98   3/29/88 X    240         210            0             0   Y F-092998
        1926.451 D03              S 01003          2/24/98   2/27/88 X    280         210            0             0   Y F-092998
        1904.008                  O 02001          2/24/88   2/27/88 X      0           0            0             0   Y F-092998
                                                          TOTAL PENALTIES 560         420            0             0

                                      ****    ACCIDENT DATA    ****
```

SUMMARY # 14312581 DATE:12-22-87 KEYWDS: DESCRIP:FALL FROM LADDER ON SCAFFOLD
ABSTRACT: TWO EMPLOYEES (CARPENTERS) WERE INSTALLING CEDAR SIDING ON A 2 STORY PRIVATE HOME. THEY WERE USING A 2 STAGE T W F SCAFFOLD 8' HIGH AND ON TOP HAD 2-12 FOOT SECTONS OF A FIBREGLASS 24' LADDER. SCAFFOLD TIPED OVER DISLODGING LADDERS, EMPLOYEES FELL TO THE GROUND. ---(ABSTRACT NOT REVIEWED)

56

57

ESTABLISHMENT INSPECTED / ADDRESS / CITY STATE ZIP / COUNTY (NAME/CODE)
REPORT ID ACTIVITY# CSHO / OPEN DATE INSP TYPE CATEGORY / CLOSECONF OPT REPT# SCOPE / CASE CLSD PREV ACT UNION / RELTD ACT
SIC1/SIC2 / $REMITTED EMPESTAB / OWNERSHIP EMPINSP LWDI / CLASS EMPCNTRL

| STANDARD | CITATION TYP | CITATION IDENT | GR RE VC | ISSUANCE DATE | ABATE DATE | ABT CMP CDE | INITIAL PENALTY | CURRENT PENALTY | INITIAL F-T-A PENALTY | CURRENT F-T-A PENALTY | C N T | SETTLM-T DISPOS-N /FINORDT | HAZD SUBS CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

******************************
ROLLINS ASSOCIATES, INC. 0213100 100709609 *** CONTINUED ***

VICTIM: 001 AGE: 25 SEX: M
DISPOSITION : FATALITY
INJ NATURE : CONCUSSION
INJ SOURCE : LADDER
PART-OF-BODY: HEAD
EVENT-TYPE : FALL(FROM ELEVATION)
ENVIR FACTOR: WORK-SURFACE/FACIL-LAYOUT COND
HUMAN FACTOR: MISJUDGMENT, HAZ. SITUATION
HAZ SUBSTNCE: NO SUBSTANCE IMPLICATED

******************************
BAST HATFIELD INC. 0213100 002263978 W5777-C 1542 79.0 12.0 8.0 24.0 10.0 25.0
828 EASTERN AVE. 9/04/86 UN-FATCAT SAFETY 1020 2
SCHENECTADY NY 12309 9/12/86 429 COMPREH PRIV SEC 2
SCHENECTADY 093 (OPEN) A360526339 NONUNION SPG-CONST 80
A360526339
OPT-INFO: N-98 X

58

| STANDARD | CITATION TYP | CITATION IDENT | ISSUANCE DATE | ABATE DATE | ABT CMP CDE | INITIAL PENALTY | CURRENT PENALTY | INITIAL F-T-A PENALTY | CURRENT F-T-A PENALTY | C N T |
|---|---|---|---|---|---|---|---|---|---|---|
| 1926.500 002 | S | 01001 | 9/15/86 | 9/18/86 | X | 720 | 720 | 0 | 0 | Y |
| 1926.450 A07 | R | 02001 | 9/15/86 | 9/18/86 | X | 1440 | 1440 | 0 | 0 | Y |
| 1926.451 D10 | R | 02002 | 9/15/86 | 9/18/86 | X | 2880 | 2880 | 0 | 0 | Y |
| | | | | TOTAL PENALTIES | | 5040 | 5040 | 0 | 0 | |

**** ACCIDENT DATA ****

SUMMARY # 14484257 DATE: 8-27-86 KEYWDS:CONSTRUCTION DESCRIP:EMPLOYEE KILLED IN FALL FROM CONSTRUCTION SCAFFOLD
ABSTRACT: ON AUGUST 27, 1986, EMPLOYEE #1 WAS WORKING ALONE ON A TUBULAR WELDED FRAME SCAFFOLD WHICH MET ALL THE REQUIREMENTS OF 1926.451. HIS HELPER HAD GONE FOR COFFEE. WHEN THE HELPER RETURNED TO THE WORK SITE HE FOUND EMPLOYEE #1 LYING ON THE ASPHALT PAVEMENT NEXT TO THE SCAFFOLD. EMPLOYEE #1 HAD APPARENTLY FALLEN, FOR UNKNOWN REASONS, BETWEEN 50 AND 75 FEET FROM THE SCAFFOLD. HE WAS TRANSPORTED TO ELLIS HOSPITAL WHERE HE DIED ON AUGUST 29, 1986. ---(ABSTRACT WAS REVIEWED)

VICTIM: 001 AGE: 25 SEX: M
DISPOSITION : FATALITY
INJ NATURE : CONCUSSION
INJ SOURCE : BUILDINGS/STRUCTURES
PART-OF-BODY: HEAD
EVENT-TYPE : FALL(FROM ELEVATION)
ENVIR FACTOR: WEATHER, EARTHQUAKE, ETC.
HUMAN FACTOR: MISJUDGMENT, HAZ. SITUATION
HAZ SUBSTNCE: NO SUBSTANCE IMPLICATED

# APPENDIX B

SPSS Database Data Definition File
and
Sample of Coded Data File

```
data list file = "c:\temp\scaffold\data.txt"
/CASE   1-4
/SUMM   1-9  TIME 11-14 MONTH 16-17  YEAR  19-20  STATE 22-23
 REGION  25-26 FINE  28-32   OWNER  34   UNION 36  CLASS 38
 EMPESTAB  40-44 EMPINSP 46-50 EMPCNTRL 52-56  USE 58  SIC  60-63
 LOCATION 65 ELEVATE 67-69
/OPERATE  1-2   SCAFFTYP 4-5  OPEN 7  WEATHER 9-10  CONTYPE 12-13
 CAUSE1 15-16 CAUSE2 18-19 DESCRIP 21-22
/VICTIM1 1-2  AGE1 4-5  DISPO1 7  NATURE1  9-10  BODPART1 12-13  EVENT1
15-16
 ENVIRO1 18-19  HUMAN1 21-22
/VICTIM2 1-2  AGE2 4-5  DISPO2 7  NATURE2  9-10  BODPART2 12-13  EVENT2
15-16
 ENVIRO2 18-19  HUMAN2 21-22
/VICTIM3 1-2  AGE3 4-5  DISPO3 7  NATURE3  9-10  BODPART3 12-13  EVENT3
15-16
 ENVIRO3 18-19  HUMAN3 21-22
/VICTIM4 1-2  AGE4 4-5  DISPO4 7  NATURE4  9-10  BODPART4 12-13  EVENT4
15-16
 ENVIRO4 18-19  HUMAN4 21-22
/VICTIM5 1-2  AGE5 4-5  DISPO5 7  NATURE5  9-10  BODPART5 12-13  EVENT5
15-16
 ENVIRO5 18-19  HUMAN5 21-22
/VICTIM6 1-2  AGE6 4-5  DISPO6 7  NATURE6  9-10  BODPART6 12-13  EVENT6
15-16
 ENVIRO6 18-19  HUMAN6 21-22
/STAND1 1-7  TYPE1 9 STAND2 11-17  TYPE2 19 STAND3 21-27  TYPE3 29
 STAND4 31-37  TYPE4 39 STAND5 41-47  TYPE5 49
/STAND6 1-7  TYPE6 9 STAND7 11-17  TYPE7 19 STAND8 21-27  TYPE8 29
 STAND9 31-37  TYPE9 39 STAND10 41-47  TYPE10 49
/DUMMY 1.

variable labels
/CASE    "Case Number"
/SUMM    "Summary / Abstract Number"
/TIME    "Time of day - 24 hour time"
/MONTH   "Month of year"
/YEAR    "Year in the 1900's"
/STATE   "State abbreviation as defined below"
/REGION  "OSHA region number"
/FINE  "Penalty paid for violations"
/OWNER  "Private or Govt activity"
/UNION  "Union or non-union activity"
/CLASS  "OSHA inspection classification (defined below)"
```

/EMPESTAB "Number of employees in establishment(employer)"
/EMPINSP "Number of employees in inspection"
/EMPCNTRL "Number of employees controlled by employer at site"
/USE "Use of scaffolding at the time (defined below)"
/SIC "Standard Industry Code of construction being performed"
/LOCATION "Location of victim(s) prior to accident (defined below)"
/ELEVATE "Elevation of working platform or victims fall height in feet"
/OPERATE "Const. operation performed at the time"
/SCAFFTYP "Type of scaffold used (defined below)"
/OPEN "Size of floor or wall opening (defined below)"
/WEATHER "Weather at time of incident (defined below)"
/CONTYPE "Type of construction (defined below)"
/CAUSE1 "First apparent cause of accident from abstract"
/CAUSE2 "Second apparent cause of accident from abstract"
/DESCRIP "General description of accident"
/VICTIM1 "Number assigned to first victim"
/AGE1 "Age of first victim"
/DISPO1 "Disposition of first victim"
/NATURE1 "Nature of injury of first victim"
/BODPART1 "Body part injured on first victim"
/EVENT1 "Type of injury event of first victim"
/ENVIRO1 "Environmental causal factor involved with first victim"
/HUMAN1 "Human causal factor involved with first victim"
/VICTIM2 "Number assigned to second victim"
/AGE2 "Age of second victim"
/DISPO2 "Disposition of second victim"
/NATURE2 "Nature of injury of second victim"
/BODPART2 "Body part injured on second victim"
/EVENT2 "Type of injury event of second victim"
/ENVIRO2 "Environmental causal factor involved with second victim"
/HUMAN2 "Human causal factor involved with second victim"
/VICTIM3 "Number assigned to third victim"
/AGE3 "Age of third victim"
/DISPO3 "Disposition of third victim"
/NATURE3 "Nature of injury of third victim"
/BODPART3 "Body part injured on third victim"
/EVENT3 "Type of injury event of third victim"
/ENVIRO3 "Environmental causal factor involved with third victim"
/HUMAN3 "Human causal factor involved with third victim"
/VICTIM4 "Number assigned to fourth victim"
/AGE4 "Age of fourth victim"
/DISPO4 "Disposition of fourth victim"
/NATURE4 "Nature of injury of fourth victim"
/BODPART4 "Body part injured on fourth victim"

/EVENT4 "Type of injury event of fourth victim"
/ENVIRO4 "Environmental causal factor involved with fourth victim"
/HUMAN4 "Human causal factor involved with fourth victim"
/VICTIM5 "Number assigned to fifth victim"
/AGE5 "Age of fifth victim"
/DISPO5 "Disposition of fifth victim"
/NATURE5 "Nature of injury of fifth victim"
/BODPART5 "Body part injured on fifth victim"
/EVENT5 "Type of injury event of fifth victim"
/ENVIRO5 "Environmental causal factor involved with fifth victim"
/HUMAN5 "Human causal factor involved with fifth victim"
/VICTIM6 "Number assigned to sixth victim"
/AGE6 "Age of sixth victim"
/DISPO6 "Disposition of sixth victim"
/NATURE6 "Nature of injury of sixth victim"
/BODPART6 "Body part injured on sixth victim"
/EVENT6 "Type of injury event of sixth victim"
/ENVIRO6 "Environmental causal factor involved with sixth victim"
/HUMAN6 "Human causal factor involved with sixth victim"
/STAND1 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE1 "Citation type (defined below)"
/STAND2 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE2 "Citation type (defined below)"
/STAND3 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE3 "Citation type (defined below)"
/STAND4 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE4 "Citation type (defined below)"
/STAND5 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE5 "Citation type (defined below)"
/STAND6 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE6 "Citation type (defined below)"
/STAND7 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE7 "Citation type (defined below)"
/STAND8 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE8 "Citation type (defined below)"
/STAND9 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE9 "Citation type (defined below)"
/STAND10 "Standard from CFR Part 1926 (indicates paragraph & subpara)"
/TYPE10 "Citation type (defined below)".

missing values
/TIME SIC (0000)
/OWNER to CLASS USE LOCATION OPEN DISPO1 DISPO2 DISPO3 DISPO4

```
    DISPO5 DISPO6 TYPE1 TYPE2 TYPE3 TYPE4 TYPE5 TYPE6 TYPE7
TYPE8
    TYPE9 TYPE10 (0)
/ELEVATE (999)
/OPERATE SCAFFTYP WEATHER CONTYPE CAUSE1 CAUSE2
    DESCRIP VICTIM1 VICTIM2 VICTIM3 VICTIM4 VICTIM5 VICTIM6
    AGE1 AGE2 AGE3 AGE4 AGE5 AGE6 NATURE1 NATURE2 NATURE3
    NATURE4 NATURE5 NATURE6 BODPART1 BODPART2 BODPART3
    BODPART4 BODPART5 BODPART6 EVENT1 EVENT2 EVENT3 EVENT4
    EVENT5 EVENT6 ENVIRO1 ENVIRO2 ENVIRO3 ENVIRO4 ENVIRO5
ENVIRO6
    HUMAN1 HUMAN2 HUMAN3 HUMAN4 HUMAN5 HUMAN6 STAND1
STAND2
    STAND3 STAND4 STAND5 STAND6 STAND7 STAND8 STAND9 STAND10
(00).

value labels
/MONTH  1 "January" 2 "Febuary" 3 "March" 4 "April" 5 "May" 6 "June"
      7 "July" 8 "August" 9 "September" 10 "October" 11 "November"
      12 "December"
/STATE  1 "Alabama" 2 "Alaska" 3 "Arizona" 4 "Arkansas" 5 "California"
      6 "Colorado" 7 "Connecticut" 8 "Delaware" 9 "District of Columbia"
      10 "Florida" 11 "Georgia" 12 "Hawaii" 13 "Idaho" 14 "Illinois"
      15 "Indiana" 16 "Iowa" 17 "Kansas" 18 "Kentucky" 19 "Louisiana"
      20 "Maine" 21 "Maryland" 22 "Massachusetts" 23 "Michigan"
      24 "Minnesota" 25 "Mississippi" 26 "Missouri" 27 "Montana"
      28 "Nebraska" 29 "Nevada" 30 "New Hampshire" 31 "New Jersey"
      32 "New Mexico" 33 "New York" 34 "North Carolina" 35 "North Dakota"
      36 "Ohio" 37 "Oklahoma" 38 "Oregon" 39 "Pennsylvania"
      40 "Rhode Island" 41 "South Carolina" 42 "South Dakota"
      43 "Tennessee" 44 "Texas" 45 "Utah" 46 "Vermont" 47 "Virgina"
      48 "Washington" 49 "West Virginia" 50 "Wisconsin" 51 "Wyoming"
      52 "Puerto Rico" 53 "Guam"
/REGION  1 "New England" 2 "New York New Jersey" 3 "Mid Atlantic"
      4 "South East" 5 "Old Northwest" 6 "Oil States" 7 "Mid West"
      8 "Rocky States" 9 "California" 10 "Northwest"
/OWNER 0 "Not Indicated" 1 "Private Sector" 2 "Local Govt." 3 "State Govt."
      4 "Federal Govt."
/UNION  0 "Not Indicated" 1 "Union" 2 "Nonunion"
/CLASS 0 "Not Indicated" 1 "Construction" 2 "Manufacturing" 3 "Other"
/USE 0 "Not Indicated" 1 "Erecting" 2 "Using" 3 "Dismantling"
      4 "Moving erected" 5 "Moving dismantled" 6 "Climbing"
/LOCATION 0 "Not Indicated" 1 "On platform" 2 "Under platform"
      3 "Above platform"
```

/OPERATE 0 "Not Indicated" 1 "Concrete Work" 2 "Painting or Caulking"
3 "HVAC work" 4 "Electrical work" 5 "Plumbing work"
6 "Siding Installation" 7 "Brick or block work" 8 "Rough Carpentry"
9 "Inspecting" 10 "Telephone linework" 11 "Drywall/Ceiling Work"
12 "Moving materials" 13 "Steelwork" 14 "Glazing related work"
15 "Roofing" 16 "Asbestos" 17 "Waterproofing Tunnel"
18 "Rock Drilling"
/SCAFFTYP 0 "Not Involved" 1 "Tube and Coupler" 2 "Tubular Welded Frame"
3 "Manually-propelled"
4 "Elevating and rotating platforms (scissor lift)"
5 "Outrigger" 6 "Mason's Adjustable Multi-point Suspension"
7 "Swinging (Two-point Suspension)"
8 "Stone Setter's Adjustable Multi-point Suspension"
9 "Single-point Adjustable Suspension"
10 "Boatswain's (Bosun's) Chair" 11 "Carpenter's Bracket"
12 "Bricklayer's Square" 13 "Horse" 14 "Needle Beam"
15 "Plaster's, decorator's, and large area" 16 "Interior Hung"
17 "Ladder Jack" 18 "Window Jack" 19 "Roofing Brackets"
20 "Crawling Boards or Chicken Ladders" 21 "Float or Ship" 22 "Form"
23 "Pump Jack" 24 "Aerial Lifts (Articulating Boom)"
25 "Non-descript" 26 "Wood Pole" 27 "Makeshift"
28 "Horizontal Wire Cable"
/OPEN 0 "Not Involved in incident" 1 "3'x3' or smaller"
2 "Between 3'x3' and 6'x6'" 3 "Larger than 6'x6'"
4 "Open-sided floor or platform"
5 "Invovled but not size not indicated"
/WEATHER 0 "Not Indicated" 1 "Fair" 2 "Raining" 3 "Wet" 4 "Snow or Ice"
5 "Wind" 6 "Hot/Humid"
/CONTYPE 0 "Not Indicated" 1 "High-rise" 2 "Residential"
3 "General Repair or Maintenance" 4 "Specialty Plants"
5 "Highway/ Road" 6 "Utilities" 07 "Bridge" 8 "Commercial"
/CAUSE1 CAUSE2 0 "Not Indicated" 1 "Inattention to overhead"
2 "Improper construction" 3 "Poor footing support"
4 "Lack of standards" 5 "Unguarded floor opening"
6 "Breaking/failure of structure" 7 "Slippery work surface"
8 "Overloading with materials" 9 "Overloading with workers"
10 "Planking unsecure or broke" 11 "No guard rails scaffold"
12 "Traffic control" 13 "No life line or net"
14 "Unlocked wheels on scaffold" 15 "Worker ignores safety devices"
16 "Weather" 17 "Other events not related"
18 "Failure of lifeline during fall from scaffold"
19 "Dropped materials from scaffold"
20 "Intoxicated"
21 "Action causing tipping" 22"Unsecure covering to floor opening"

23 "Guardrails failed to hold" 24 "Covering to opening broke"
/DESCRIP 0 "Not Indicated" 1 "Electrical Shock - Scaffold"
2 "Fall from Scaffold" 3 "Fall from Floor Opening"
4 "Pinch-point Scaffold" 5 "Fall from wall opening"
6 "Fall from both scaffold and floor opening"
7 "Lifeline prevented fall from scaffold"
8 "Dropped materials from scaffold"
9 "Mobile scaffold impact on object"
10 "Fall from Scaffold and Collapse"
11 "Dropped materials on scaffold"
12 "Fall from roof or platform edge"
/DISPO1 DISPO2 DISPO3 DISPO4 DISPO5 DISPO6 0 "Not Indicated"
1 "Hospitalized injury" 2 "Non-hospitalized injury" 3 "Fatality"
/NATURE1 NATURE2 NATURE3 NATURE4 NATURE5 NATURE6 0 "Not Indicated
"
1 " Amputation " 2 "Asphyxia" 3 "Bruise, contusion, abrasion"
4 "Burn (chemical)" 5 "Burn or scald (heat)" 6 "Concussion"
7 "Cut or laceration" 8 "Dermititis" 9 "Dislocation"
10 "Electric Shock" 11 "Foreign body in eye" 12 "Fracture"
13 "Freezing or frost bite" 14 "Hearing loss" 15 "Heat exhaustion"
16 "Hernia" 17 "Poisoning (systemic)" 18 "Puncture"
19 "Radiation effect" 20 "Strain or sprain" 21 "Other" 22 "Cancer"
/BODPART1 BODPART2 BODPART3 BODPART4 BODPART5 BODPART6
0 "Not Indicated"
1 " Abdomen " 2 " Arm(s) - multiple" 3 "Back" 4 "Body System"
5 "Chest" 6 "Ear(s)" 7 "Elbow(s)" 8 "Eye(s)" 9 "Face" 10 "Finger(s)"
11 "Foot, feet, toes, or ankle(s)" 12 "Hand(s)" 13 "Head" 14 "Hip(s)"
15 "Knee(s)" 16 "Leg(s)" 17 "Lower arm(s)" 18 "Lower leg(s)"
19 "Multiple" 20 "Neck" 21 "Shoulders" 22 "Upper arm(s)"
23 "Upper leg(s)" 24 "Wrist(s)" 25 "Blood" 26 "Kidney" 27 "Liver"
28 "Lung" 29 "Nervous system" 30 "Reproductive system"
31 "Other body system"
/EVENT1 EVENT2 EVENT3 EVENT4 EVENT5 EVENT6 0 "Not Indicated" 1
"Struck by"
2 " Caught in or between" 3 "Bite, sting or scratch"
4 "Fall (same level)" 5 "Fall (from elevation)" 6 "Struck against"
7 "Rubbed or abraded" 8 "Inhalation" 9 "Ingestion" 10 "Absorption"
11 "Repeated motion or pressure" 12 "Cardio-vascular/respiratory"
13 "Shock" 14 "Other"
/ENVIRO1 ENVIRO2 ENVIRO3 ENVIRO4 ENVIRO5 ENVIRO6 0 "Not Indicated"
1 "Pinch point action" 2 "Catch point / puncture action"
3 "Shear point action" 4 "Squeeze point action"
5 "Flying object action" 6 "Overhead moving / falling object action"
7 "Gas, vapor, etc. condition"

8 "Materials handling equipment or method" 9 "Chemical action"
10 "Flammable liquid/solid exposure" 11 "Temperature tolerance"
12 "Radiation" 13 "Working surface or facility layout condition"
14 "Illumination" 15 "Over/underpressure condition" 16 "Sound level"
17 "Weather, earthquake, etc. condition" 18 "Other"
/HUMAN1 HUMAN2 HUMAN3 HUMAN4 HUMAN5 HUMAN6 0 "Not Indicated"
1 "Misjudgment of hazardous condition"
4 "Malfunct. of procedure. for warning of haz. situation"
5 "Distracting actions by others"
6 "Equipment in use not appropriate for operation or process"
7 "Mafunction of neuro muscular system"
8 "Malfunct. of perception system WRT task environment"
9 "Safety devices removed or inoperative"
10 "Operational position not appropriate for task"
11 "Procedure for handling mtls not appropriate for task"
12 "Defective equipment: knowingly used"
13 "Malfunction of procedure for lock out or tag out"
14 "Other" 15 "Insufficient or lack of housekeeping program"
16 "Insufficient or lack of exposure or biological monitoring"
17 "Insufficient or lack of engineering controls"
18 "Insufficient or lack of written work practices program"
19 "Insufficient or lack of respiratory protection"
20 "Insuf. or lack of protective work clothing & equipment"
/TYPE1 TYPE2 TYPE3 TYPE4 TYPE5 TYPE6 TYPE7 TYPE8 TYPE9 TYPE10
0 "Not Indicated" 1 "Serious" 2 "Other" 3 "Willful" 4 "Repeat"
5 "Eminent Danger".

Recode SIC (1521 thru 1522=1520) (1541 thru 1542=1540) (1622 thru 1629=1620)
(1741 thru 1743=1740) (1793 thru 1799=1790) (0001 thru 1500=1)
(1800 thru 9999=1).
variable labels SIC "Codes grouped to major categories".
value labels SIC 1520 "General Building Contractors - Residential"
1531 "General Building Contractors - Operative Builders"
1540 "General Building Contractors - Nonresidential"
1611 "Heavy Construction - Highway/Street"
1620 "Heavy Construction - Non-Highway"
1711 "Plumbing, Heating, Air Conditioning"
1721 "Painting and Paper Hanging"
1731 "Electrical Work"
1740 "Masonry, Stonework, Plastering"
1751 "Carpentry Work"
1761 "Roofing, Siding, Sheet Metal Work"
1771 " Concrete Work"
1791 "Structural Steel Erection"

1790 "Misc. Specialty Trades" 1 "Others".

Recode EMPESTAB (1 thru 5=1) (6 thru 10=2) (11 thru 20=3) (21 thru 50=4)
(51 thru 75=5) (76 thru 100=6) (101 thru 500=7) (501 thru 1000=8)
(1001 thru 99999=9).
variable labels EMPESTAB "Employees in establishment collapsed into segments".
value labels EMPESTAB 1 "1 - 5" 2 "6 - 10" 3 "11 - 20" 4 "21 - 50" 5 "51 - 75"
6 "76 - 100" 7 "101- 500" 8 "501 - 1000" 9 "> 1000"

Recode time (0600 thru 0659=6) (0700 thru 0759=7) (0800 thru 0859=8)
(0900 thru 0959=9) (1000 thru 1059=10) (1100 thru 1159=11)
(1200 thru 1259=12) (1300 thru 1359=13) (1400 thru 1459=14)
(1500 thru 1559=15) (1600 thru 1659=16) (1700 thru 1759=17)
(1800 thru 2400=1) (0001 thru 0559=2).
variable labels time "Time collapsed into hour segments".
value labels time 6 "0600-0700" 7 "0700-0800" 8 "0800-0900" 9 "0900-1000"
10 "1000-1100" 11 "1100-1200" 12 "1200-1300" 13 "1300-1400"
14 "1400-1500" 15 "1500-1600" 16 "1600-1700" 17 "1700-1800"
1 "1800-2400" 2 "2400-0600".

Recode fine (1 thru 200=1) (201 thru 500=2) (501 thru 1000=3)
(1001 thru 5000=4) (5001 thru 10000=5) (10001 thru 50000=6)
(50001 thru 99998=7).
variable labels fine "Fines collapsed into segments".
value labels fine 0 "No fine issued or fine dropped" 1 "$1 - $200"
2 "$201 - $500" 3 "$501 - $1,000" 4 "$1,001 - $5,000" 5 "$5,001 - $10,000"
6 "$10,001 - $50,000" 7 "$50,001 - $100,000" 99999 ">$100,000".

Recode Elevate (1 thru 10=1) (11 thru 20=2) (21 thru 30=3)
(31 thru 40=4) (41 thru 50=5) (51 thru 60=6) (61 thru 70=7)
(71 thru 80=8) (81 thru 90=9) (91 thru 100=10) (101 thru 998=11).
variable labels Elevate "Platform elevation in feet collapsed into segments".
value labels Elevate 1 "1 - 10" 2 "11 - 20" 3 "21 - 30" 4 "31 - 40"
5 "41 - 50" 6 "51 - 60" 7 "61 - 70" 8 "71 - 80" 9 "81 - 90" 10 "91 - 100"
11 ">100".

Recode victim1 victim2 victim3 victim4 victim5 victim6 (01 thru 06=1) (00=0).
Count victim = victim1 victim2 victim3 victim4 victim5 victim6 (1).
variable labels victim "Total injured persons in each incident".

Count Hosp = Dispo1 Dispo2 Dispo3 Dispo4 Dispo5 Dispo6 (1).
variable labels Hosp "Number of Hospitalized Injuries".

Count NonHosp = Dispo1 Dispo2 Dispo3 Dispo4 Dispo5 Dispo6 (2).
variable labels NonHosp "Number of Non-Hospitalized Injuries".

Count Fatal = Dispo1 Dispo2 Dispo3 Dispo4 Dispo5 Dispo6 (3).
variable labels Fatal "Number of Fatal Injuries".

Sample of data.txt file of coded data from IMIS information:

```
0001
014477830 0000 10 85 20 01 00300 1 2 1 00010 00010 00035 4 1541 0 000
06 03 0 00 00 01 00 01
01 19 2 10 04 12 13 18
02 36 3 10 04 12 13 18
03 25 2 10 04 12 13 18
04 19 2 10 04 12 13 18
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
3030303 1 4000302 1 4510510 1 5000401 4 0200203 2
2510501 2 4500101 2 6020301 2 0000000 0 0000000 0

0002
014477889 0000 05 86 20 01 00377 1 2 1 00005 00003 00005 2 1522 1 020
06 23 0 00 00 02 00 10
01 28 2 03 19 05 06 17
02 29 1 03 19 05 06 17
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
4510112 1 4510410 1 4512504 1 0210202 1 4512511 1
4512503 1 4510113 2 4510407 2 4512505 2 0000000 0

0003
014477947 0000 06 86 20 01 00000 1 2 0 00000 00000 00000 2 1521 1 012
06 13 0 00 02 03 04 02
01 42 1 20 03 05 13 01
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
0000000 0 0000000 0 0000000 0 0000000 0 0000000 0
0000000 0 0000000 0 0000000 0 0000000 0 0000000 0

0004
014265235 1530 04 85 22 01 00350 1 1 1 00003 00003 00010 0 1795 0 050
07 00 5 00 00 05 00 03
01 31 3 06 13 05 18 09
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
00 00 0 00 00 00 00 00
8500900 1 0000000 0 0000000 0 0000000 0 0000000 0
0000000 0 0000000 0 0000000 0 0000000 0 0000000 0
```

## APPENDIX C

### OSHA Regions and State-Plan States

| | |
|---|---|
| Region I - New England: | Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont* |
| Region II - East: | New Jersey, New York, Puerto Rico, Virgin Islands |
| Region III - Mid Atlantic: | District of Columbia, Delaware, Maryland*, Pennsylvania, Virginia*, West Virginia |
| Region IV - South East: | Alabama, Florida, Georgia, Kentucky*, Mississippi, North Carolina*, South Carolina*, Tennessee* |
| Region V - Old Northwest: | Illinois, Indiana*, Michigan*, Minnesota*, Ohio, Wisconsin |
| Region VI - Oil States: | Arkansas, Louisiana, New Mexico*, Oklahoma, Texas |
| Region VII - Midwest: | Iowa*, Kansas, Missouri, Nebraska |
| Region VIII - Rocky States: | Colorado, Montana, North Dakota, South Dakota, Utah*, Wyoming* |
| Region IX - Pacific: | Arizona*, California*, Hawaii*, Nevada* |
| Region X - Northwest: | Alaska*, Idaho, Oregon*, Washington* |

* These states and territories implement their own OSHA-monitored programs as allowed by the Occupational Safety and Health Act provisions.

## APPENDIX D

### Selective List of Standard Industrial Classification Titles for Construction

| *SIC Code* | *Industry Titles* |
|---|---|
| **15** | **GENERAL BUILDING CONTRACTORS** |
| 152 | Residential Building Construction |
| 153 | Operative Builders |
| 1531 | Operative Builders |
| 154 | Nonresidential Building Construction |
| **16** | **HEAVY CONSTRUCTION**, except Building Construction |
| 161 | Highway and Street Construction |
| 1611 | Highway and Street Construction |
| 162 | Heavy Construction, except Highway |
| **17** | **SPECIAL TRADE CONTRACTORS** |
| 171 | Plumbing, Heating, Air-Conditioning |
| 1711 | Plumbing, Heating, Air-Conditioning |
| 172 | Painting and Paper Hanging |
| 1721 | Painting and Paper Hanging |
| 173 | Electrical Work |
| 1731 | Electrical Work |
| 174 | Masonry, Stonework, and Plastering |
| 175 | Carpentry and Floor Work |
| 1751 | Carpentry Work |
| 176 | Roofing, Siding, and Sheet Metal Work |
| 1761 | Roofing, Siding, and Sheet Metal Work |
| 177 | Concrete Work |
| 1771 | Concrete Work |
| 179 | Misc. Special Trade Contractors |
| 1791 | Structural Steel Erection |